



2a

HAVO | VWO

your biology
TEXTBOOK

your biology

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your biology
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your biology

BIOLOGIE VOOR TWEETALIG ONDERWIJS
HAVO|VWO ONDERBOUW

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Introduction

This biology book is part 2a of *Your Biology*. Browsing through the book will show you exactly how it is structured. The way we wrote this book will let you work with it on your own.

You can also ask your teacher for help if you need it.

There is a workbook that belongs with this book, as well as an answer key and the Your Biology website. The website has a digital version of the workbook and/or textbook. There is also the possibility of practising with digital material (including the diagnostic tests).

WORKING WITH YOUR BIOLOGY

The topics in this book are called units. Each unit starts off with an introduction.

This gives a brief description of what you can expect in the unit.

Each unit is made up of the following sections:

- Basics
- Extra
- Summary
- Diagnostic test
- Extension

We will now describe how to work with each of these sections.

BASICS

The Basics contain texts and figures that you are going to read. You will come across references to the exercises that are in the workbook, for example:

WB EXERCISE 1, PAGE 6

You should do the exercises in your workbook.

There is sometimes an optional exercise at the end of the Basics. Your teacher will tell you whether you have to do the optional exercise.

When you have finished the exercises, you will find a reference back to the textbook, for example:

TB BASICS 2, PAGE 10

Sometimes you will have to use the Internet for an exercise.

There are also some exercises that you need a worksheet for. The worksheets are in the workbook. It is useful if you have a pair of scissors and a glue stick. As well as the pens you normally write with, you will need a drawing pencil (HB) and coloured pencils. You can use the answer key to check the exercises yourself.

EXTRA

At the end of the Basics, you will find the Extra section. Once you have finished the Basics, your teacher will tell you whether you have to do the Extra. The completed exercises from the Extra section can be checked with the answer key.

SUMMARY

The summary gives a brief description of what you have learned in the basics and (if you did it) the extra section. This is what you will have to 'know and do' for a test.

DIAGNOSTIC TEST

The diagnostic test lets you see whether you know and can do everything that is in the summary. You can check the diagnostic test using the answer key.

You can also do the diagnostic test via the Your Biology website. You can then see straight away whether your answers are correct.

EXTENSION

If you know and can do everything that is in the summary, you can start on the Extension. This is additional material, with different sections that you can choose between. You do not have to do all the sections; your teacher will tell you how many you have to choose. There are more Extension sections on the Your Biology website.

The exercises in the Extension that are in the workbook can also be checked using the answer key.

We hope that you will enjoy working with this book.

The authors

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1

Breathing and respiration



BASICS

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- 2 Inhaled air and exhaled air
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This unit is called 'Breathing and respiration'.

Respiration is a kind of combustion that takes place inside your body. It gives you energy to do things and to keep your body warm. This unit teaches you about the process of respiration. For respiration your body needs oxygen. Respiration also generates another gas, carbon dioxide. Breathing makes air flow in and out of the lungs. The respiratory system is where breathing takes place. You will learn how respiration works in this unit. You will also learn about reasons why your lungs may work less well.

When you read the basics, you will come across the exercises as you go. You should do the exercises in your workbook.

1 Respiration is similar to combustion

Most cars have an internal combustion engine. The word 'combustion' means burning. So this is an engine that burns **fuel** inside it. The fuel used by cars is often petrol.

The combustion lets the car move. The engine gets warm too. We say that the combustion has released energy in the form of **movement** and **heat**.

When the fuel is burned, it disappears and other substances appear in its place. The substances produced by combustion are referred to as **combustion products**. The internal combustion in the car's engine uses up the petrol and produces exhaust gases. The exhaust gases are the combustion products (see figure 1).

WB EXERCISE 1, PAGE 6

► **Fig. 1** When fuel is burned in a car engine, combustion products are made.



▼ **Fig. 2** The bubbles in mineral water are made of carbon dioxide.



BURNING A CANDLE

A candle is made of candle wax. When a candle is burned, the candle wax disappears. The candle wax is the fuel. Burning the fuel creates combustion products and energy is released in the form of **light** and **heat**.

After the jam jar in exercise 1 has been put over the burning candle, the flame goes out. This is because the oxygen in the jam jar has then been used up.

Combustion needs **oxygen**.

Combustion produces **water** and **carbon dioxide**. The water can also be seen as condensation on the inside of the jam jar.

In part 1, you learned that carbon dioxide is a gas that is present in the air. It is also in the bubbles in a soft drink or mineral water (see figure 2). There is a test for showing if carbon dioxide is present.

WB EXERCISES 2 AND 3, PAGE 7

AN INDICATOR

In exercise 2, you have seen that clear limewater goes cloudy if it comes into contact with carbon dioxide. Clear limewater lets you show that carbon dioxide is present. A substance that can be used to demonstrate the presence of another is called an **indicator**. Clear limewater is the indicator for carbon dioxide (see figure 3).

WB EXERCISES 4 AND 5, PAGE 8

▼ **Fig. 3** Limewater.



1 clear limewater



2 cloudy limewater

2 Inhaled air and exhaled air

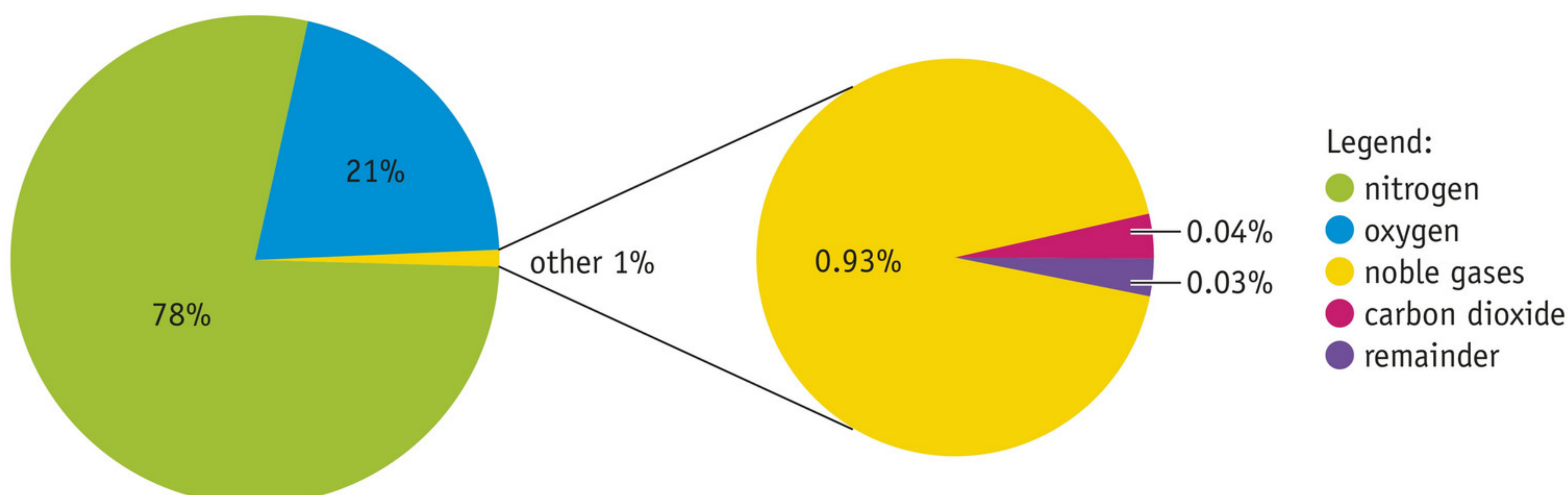
Air is a mixture of several different gases. You cannot see the gases in air, but it is possible to feel or see the effects of air, for example when you blow the fluff off a dandelion (figure 4). Air consists largely of nitrogen and oxygen. As well as that, there are the inert (or 'noble') gases and a little bit of carbon dioxide.

The air also always contains water vapour, although the amount of water varies. The composition is therefore often stated for dry air. Figure 5 shows you the gases that are present in dry air.

► **Fig. 4** The fluff of a dandelion.



▼ **Fig. 5** The composition of dry air.



You breathe air in and out again. The composition of the air that you breathe out (exhale) is not the same as the air you breathed in (inhale). You have learned how to test for the presence of carbon dioxide. The presence of oxygen can be shown using a burning candle. In the following exercises, you will look at the differences between inhaled and exhaled air.

3 Respiration in organisms

When you breathe in, you are taking in **oxygen** from the air. In basics 1, you learned that a burning candle uses oxygen.

When you breathe out, you are getting rid of **carbon dioxide** to the surrounding air. You also lose **water** and **energy (heat)** when you exhale. In basics 1, you learned that the combustion of a candle creates carbon dioxide and water, and that this releases energy.

A kind of combustion also takes place inside your body. The combustion inside your body goes much more slowly than in a candle and it does not use fire. This combustion – called **respiration** – takes place in every single cell in your body. It goes on all the time, day and night. Without respiration, a cell dies. That is not just true for human cells: it applies to every living cell in every organism.

Respiration needs **fuel**. The most commonly used fuel in cells is glucose. In part 1, you learned that plants produce glucose by photosynthesis. You have also learned that plants can make all kinds of other substances from glucose, including the substances that they themselves are made from. Humans and animals then live on those substances. When we eat plants, we take these substances in as part of our food.

Respiration also releases **energy**. All the organs in your body need energy. For example, you need energy to move and to keep your body temperature at 37°C.

► **Fig. 6** All organisms need energy.



1 in order to move



2 to maintain body temperature

ENERGY

You need energy to do things. For example, you need energy to make your body move, to stay warm and to grow. Energy changes from one form to another as this happens. During respiration, the energy from glucose does not disappear. Instead, it is converted into movement and heat. The heat is then given off to the surroundings and the body can do nothing with it after that. When you are more active, you need more energy. So respiration increases. All kinds of organs in your body then work harder to make sure that the cells get enough fuel and oxygen and to remove the products of respiration.

COLD-BLOODED AND WARM-BLOODED

In part 1, you learned that there are cold-blooded and warm-blooded animals. In **cold-blooded animals**, the body temperature is roughly the same as the temperature of the surroundings that the animal lives in. The body temperature is therefore not always the same. In **warm-blooded animals**, the body temperature is constant (always the same). Most animals are cold-blooded. Only birds and mammals are warm-blooded.

Respiration in cells depends on the temperature. The higher the body temperature, the more respiration takes place. If the temperature of the surroundings is low, the body temperature of cold-blooded animals is also low. Not much respiration is then taking place in their bodies. If respiration is slow, there is not much energy available. This is why cold-blooded animals are not very active in cold weather.

Many cold-blooded animals **hibernate** during the winter. Frogs, for example, bury themselves in the mud of a ditch or pond and hibernate there.

Birds and mammals have a constant body temperature. This makes them less dependent on the temperature of the surroundings. Their bodies have high respiration rates. This releases a lot of energy. As a result, many birds and mammals are also able to keep active during the winter.

In the winter, extra energy is needed to maintain their body temperature, which means they need a lot of food. The animals have to move around a lot to find that food, and that needs energy as well and therefore even more food. Particularly when there is snow on the ground, it can be difficult for the animals to find food. This is why many people feed birds during the winter with high-energy foodstuffs such as suet balls.

Warm-blooded animals need insulation to help keep their body temperatures constant. Mammals have a layer of fat under the skin and a thick coat of fur. Birds also have a layer of fat under the skin and a thick layer of feathers.

▼ **Fig. 7** A frog is cold-blooded.



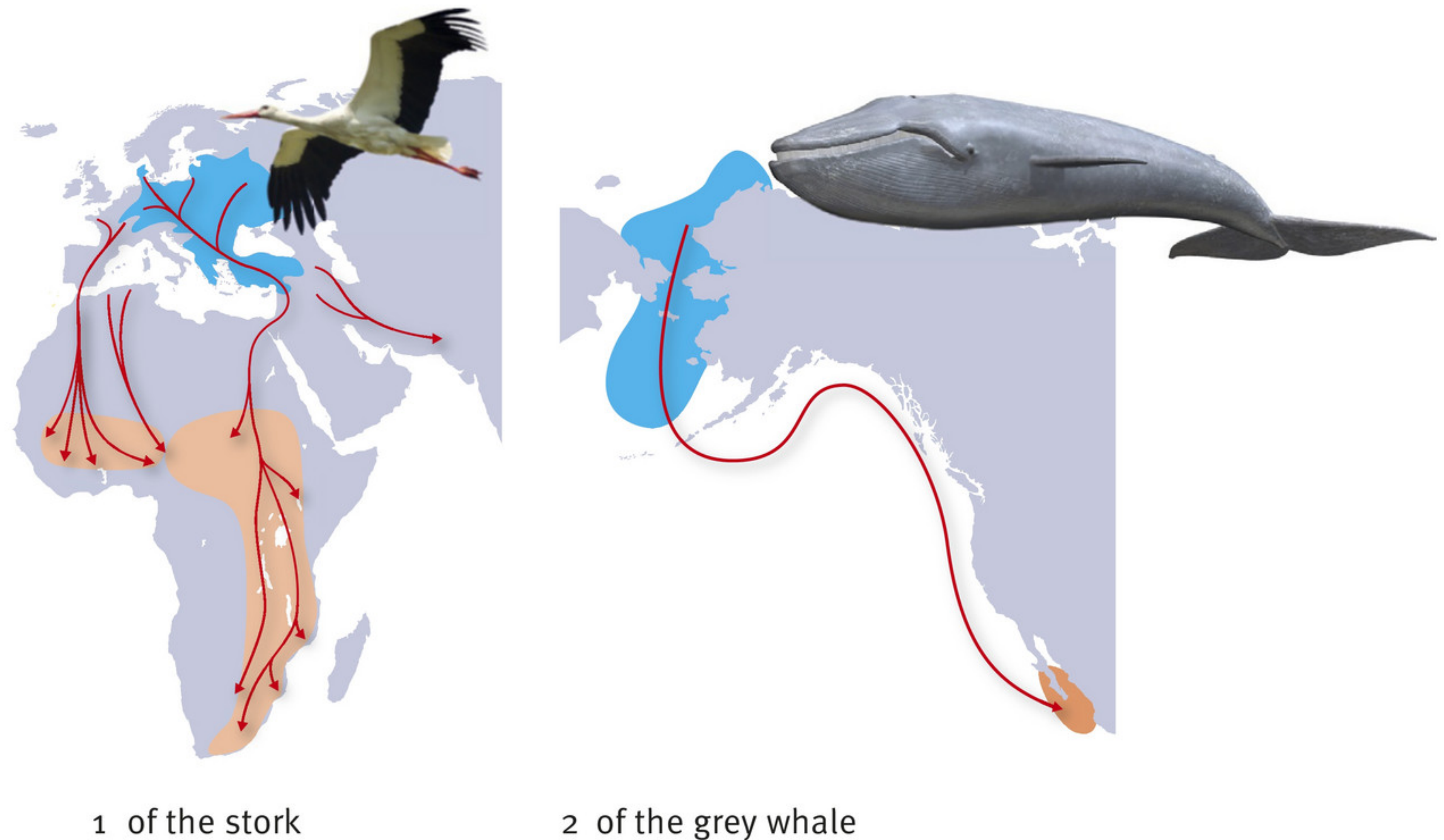
1 active in the summer



2 passive in the winter

Many birds migrate in the autumn, leaving for warmer climates (see figure 8.1). Some mammals migrate as well. Grey whales migrate to warmer waters in the autumn, for instance (see figure 8.2).

► **Fig. 8** Migration routes.



Some mammals also hibernate, such as hedgehogs and bats for example. During hibernation, the body temperatures of these animals drops and they need less energy. If hibernating bats are disturbed, they often die as a result. All the bat species that live in the Netherlands are protected (see figure 9).

WB EXERCISES 10 TO 14, PAGE 13

▼ **Fig. 9**

Bats are protected

Because of their habit of roosting together in large groups, bats are very vulnerable. If their rest is disturbed, an entire colony can be destroyed. There are not many good daytime resting places (hollow trees) nor many good places to hibernate through the winter where they will not be disturbed and where the winter temperature does not fall below freezing. During hibernation, bats live from the food reserves they have stored in their bodies.

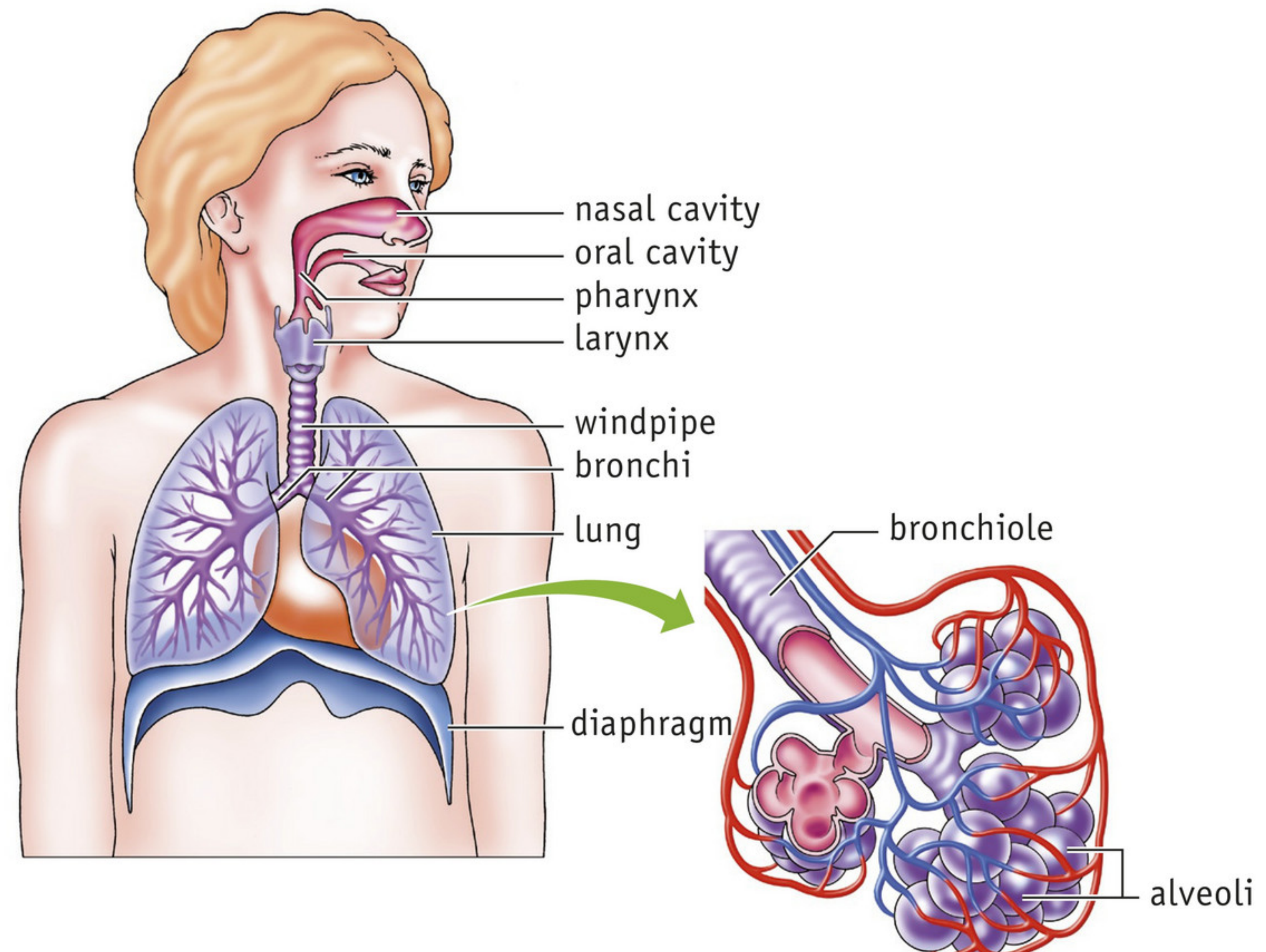
In Limburg, a number of bunkers from the Second World War have been set up as places where bats can spend the winter. But because the padlocks on the door were regularly broken, the bats could easily be disturbed. Now the doors have been welded together to prevent vandalism and ensure that the bats are left in peace, so that more of them will survive the winter.



4 The respiratory system

Figure 10 is a diagram of the human respiratory system. When you breathe in, air comes in through the **nasal cavity** or **oral cavity** into the **pharynx**. The air then flows past the **voice box (larynx)** into the **windpipe (trachea)**. The windpipe then splits into two **bronchi**, which in turn split into smaller and smaller tubes called **bronchioles**. At the ends of the bronchioles, there are bundles of air sacs called **alveoli**.

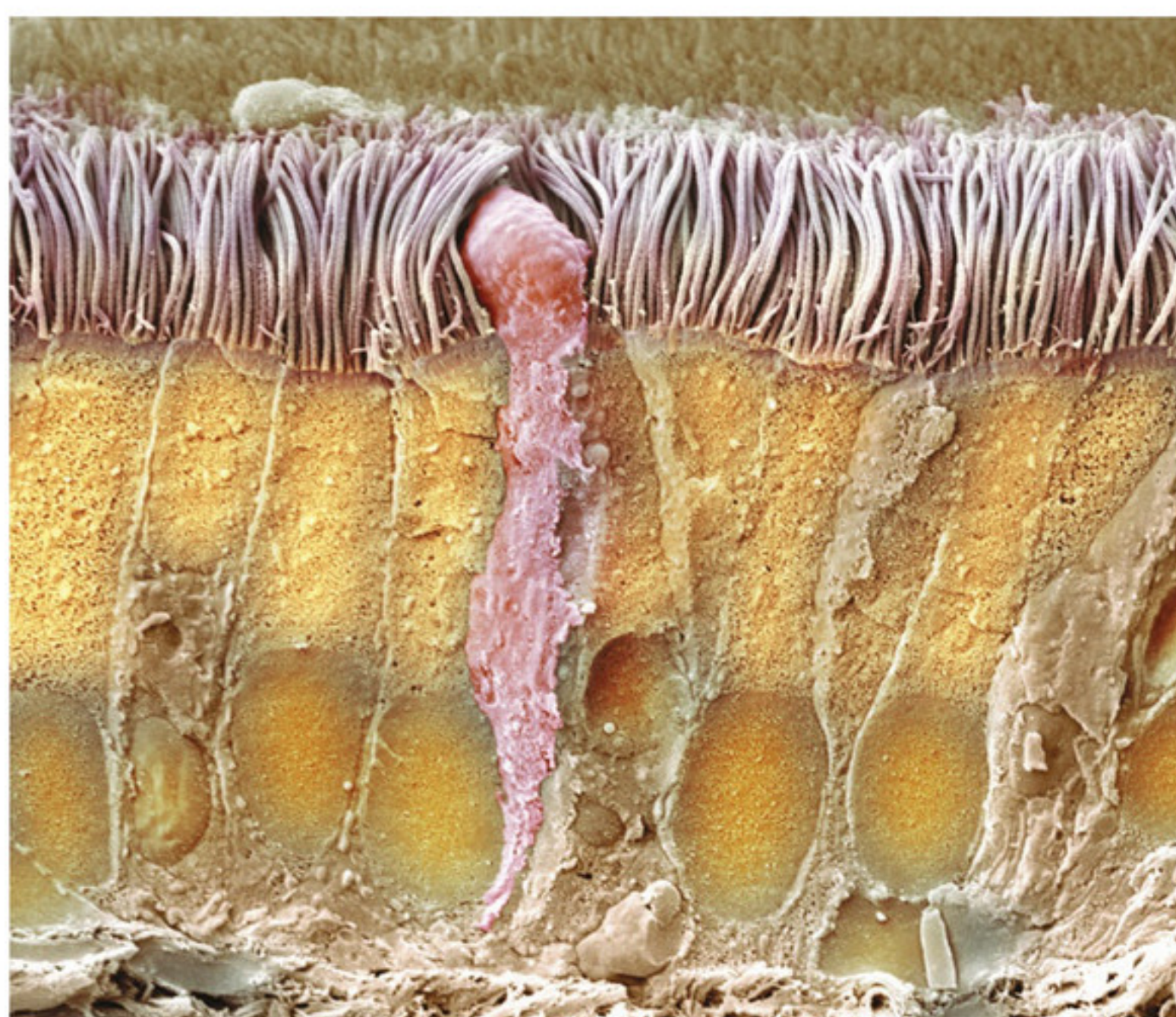
► **Fig. 10** The human respiratory system.



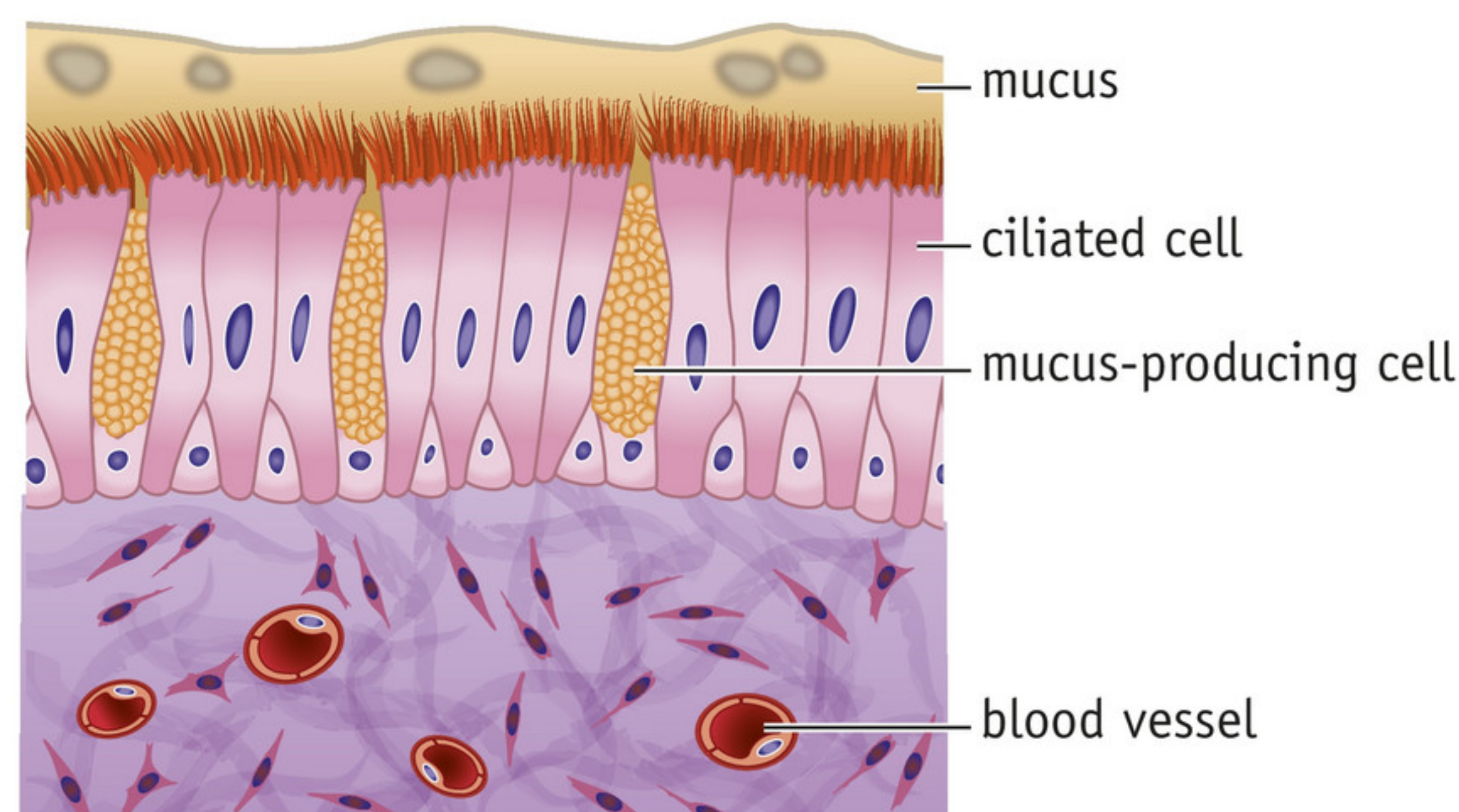
NASAL CAVITY AND ORAL CAVITY

Most people usually breathe through their noses. The nasal cavity is covered with the **nasal lining**, which has **mucus-producing cells** (see figure 11). Such a skin-like lining that produces mucus is also called a **mucous membrane**. The mucus means that the nasal cavity is moist, and so the inhaled air is also moistened. There are also lots of small blood vessels just under the surface of the nasal lining. The blood keeps the nasal lining warm and so the inhaled air is warmed too.

▼ **Fig. 11** Nasal lining.



1 electron microscope photo (SEM, 1500× magnification)



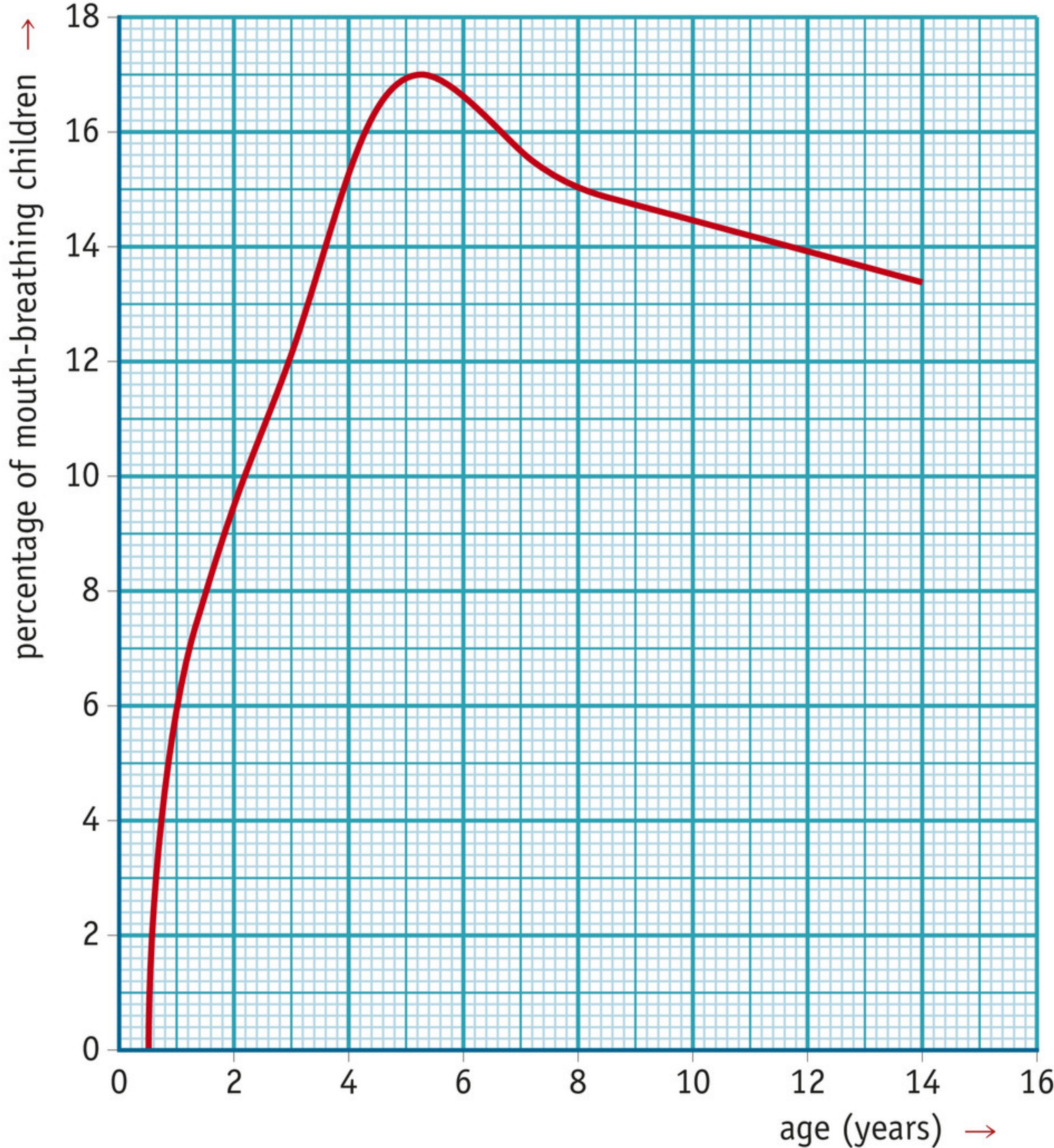
2 drawing

The air that you breathe in often contains dust particles and germs. In the front part of the nasal cavity, there are **nasal hairs** that trap any larger dust particles. Smaller dust particles and germs stick to the nasal lining. Small hairs called **cilia** sweep the mucus towards the back of the pharynx where it is then swallowed.

The sense of smell – the **olfactory system** – is located in the roof of the nasal cavity. It checks the incoming air and warns you if it contains smelly gases, for example.

When you breathe in through your mouth, the inhaled air is not cleaned, warmed or moistened as much. Your sense of smell is less good then too. Breathing through the nose is therefore healthier than breathing through the mouth. Some children cannot breathe very easily through their noses. They breathe through their mouths instead. If very dry, cold air gets into the alveoli, it can cause inflammation (see figure 12).

▼ Fig. 12

INVESTIGATION	HABITUAL MOUTH BREATHING																																
Introduction	When your nose is blocked, you sometimes have to breathe through your mouth. Some people however do that all the time. This is called habitual mouth breathing. Research has shown that children who habitually breathe through their mouth get infections of the airways more often than children who breathe through their nose.																																
Problem definition	How common is habitual mouth breathing among children?																																
Method	In 450 children, varying in age from 6 months to 14 years, habitual mouth breathing was confirmed by condensation on a cold metal mirror that was placed in front of the sleeping child's mouth. This was done once an evening for a week. If condensation was seen on the mirror every evening, the child was considered to be a habitual mouth breather. The children were subdivided into age groups and the results shown as a percentage of the total.																																
Results	 <table border="1"><caption>Data points estimated from the graph</caption><thead><tr><th>Age (years)</th><th>Percentage of mouth-breathing children</th></tr></thead><tbody><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>6</td></tr><tr><td>2</td><td>9</td></tr><tr><td>3</td><td>12</td></tr><tr><td>4</td><td>15</td></tr><tr><td>5</td><td>17</td></tr><tr><td>6</td><td>16.5</td></tr><tr><td>7</td><td>15.5</td></tr><tr><td>8</td><td>15</td></tr><tr><td>9</td><td>14.5</td></tr><tr><td>10</td><td>14.2</td></tr><tr><td>11</td><td>14</td></tr><tr><td>12</td><td>13.8</td></tr><tr><td>13</td><td>13.6</td></tr><tr><td>14</td><td>13.5</td></tr></tbody></table>	Age (years)	Percentage of mouth-breathing children	0	0	1	6	2	9	3	12	4	15	5	17	6	16.5	7	15.5	8	15	9	14.5	10	14.2	11	14	12	13.8	13	13.6	14	13.5
Age (years)	Percentage of mouth-breathing children																																
0	0																																
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12	13.8																																
13	13.6																																
14	13.5																																
Conclusion	Habitual mouth breathing occurs a lot. It can be one cause of regular infections of the airways. Investigating the treatment of habitual mouth breathing would seem to be important.																																

▼ **Fig 13** The Adam's apple.

Adam's apple

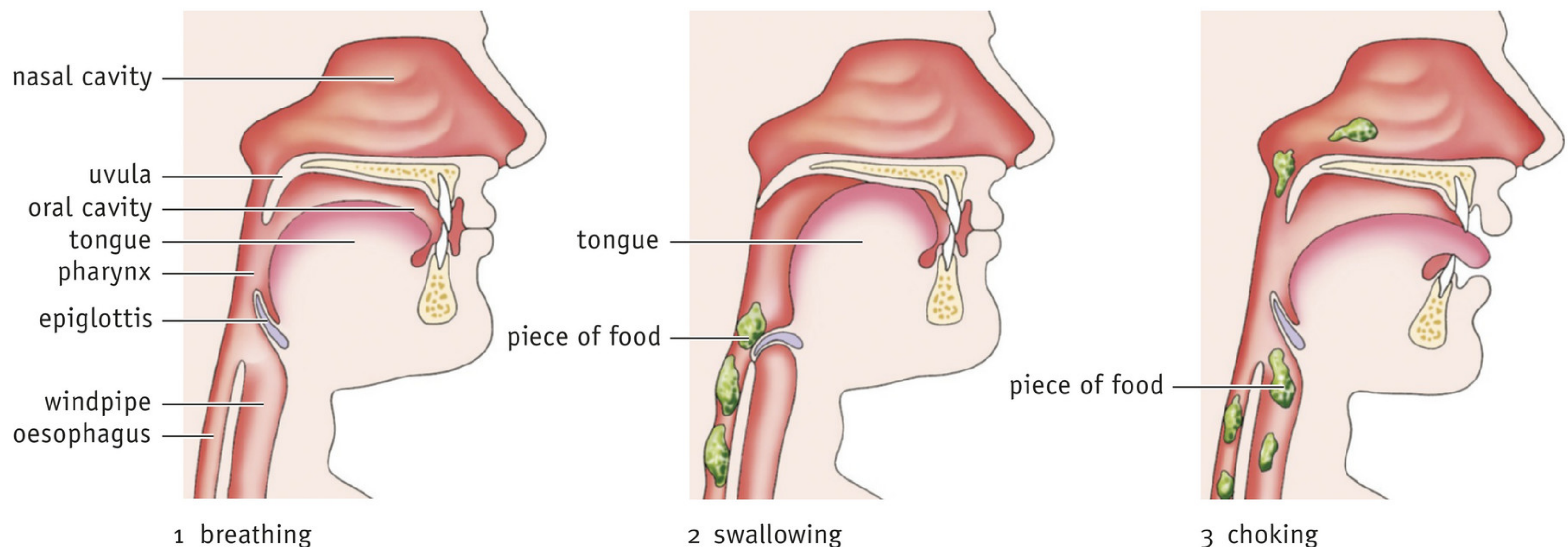
PHARYNX

After the nasal cavity or oral cavity, the air passes through the pharynx and goes into the windpipe.

The **larynx** or **voice box** is located between the pharynx and the windpipe. You can feel the larynx on the outside of your throat as the Adam's apple (see figure 13). The larynx contains the **vocal cords**. You can learn more about this in extension 1.

The pharynx is where the path taken by your food crosses the path taken by the air you breathe. When you inhale, all the routes to this 'crossroads' are open. The air can then flow from your nasal cavity into your lungs through the windpipe and back out again (see figure 14.1). When you swallow food, the **uvula** closes off the nasal cavity and the **epiglottis** closes off the windpipe (see figure 14.2). The food is then able to get from the oral cavity into the gullet (oesophagus), but will not end up in the nasal cavity or windpipe. Sometimes the epiglottis and the uvula do not close properly, for instance if you are laughing. This can make you choke – in other words, food or drink can slip into the windpipe or get into the nasal cavity (see figure 14.3). Coughing then removes the food particles from the windpipe again.

Small children often put objects in their mouths. If they then choke, the object can end up in their lungs. A radiologist can then take a photo or scan to detect the object in the lungs (see figure 15).

WB EXERCISES 15 TO 17, PAGE 16▼ **Fig. 14** Uvula and epiglottis during breathing, swallowing and choking (schematic).

▼ Fig. 15

Radiology technician

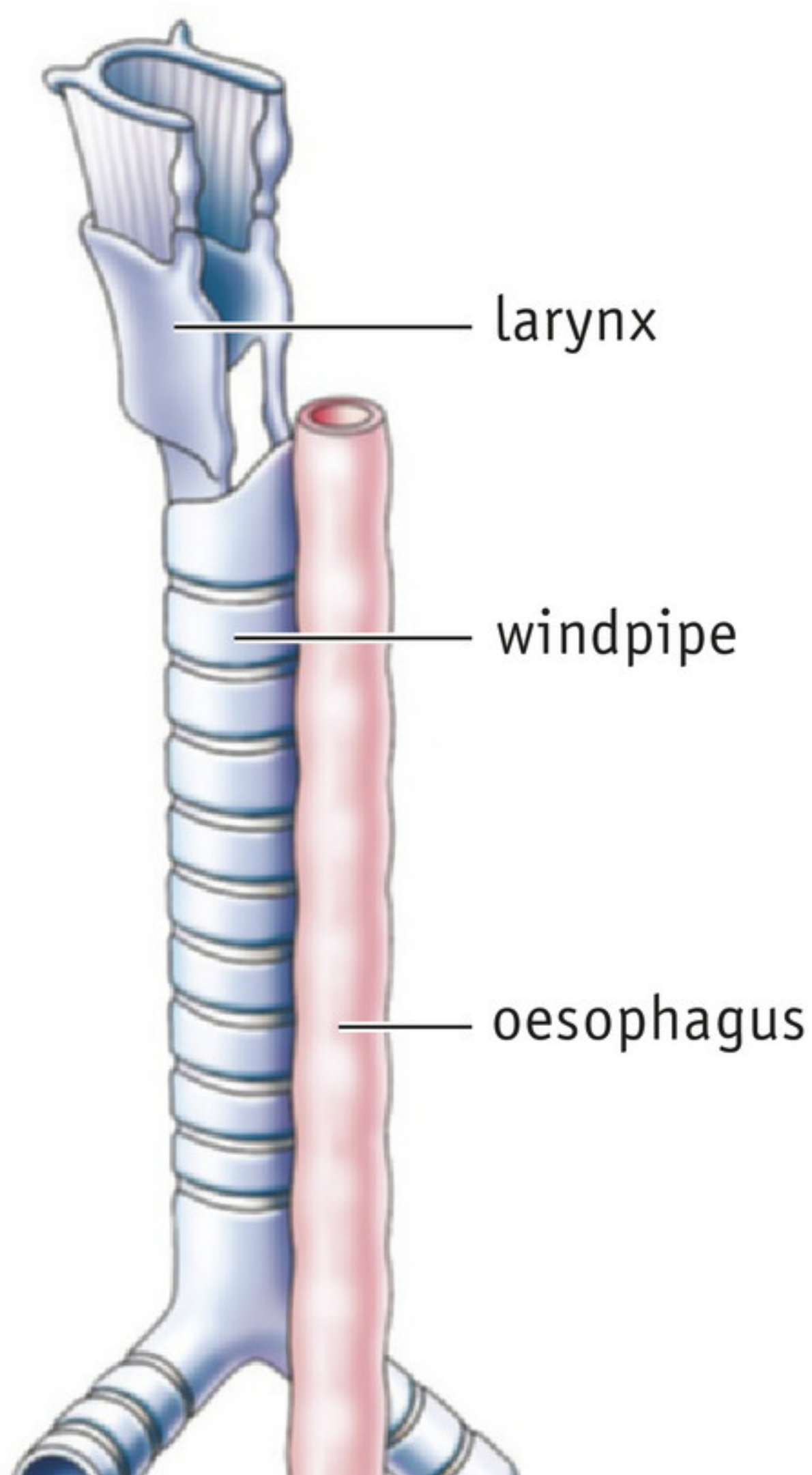
“Hallo. My name is Harry and I’m a radiology technician. Radiology technicians usually work in a hospital, where they make X-rays, scans and ultrasound images. An X-ray basically gives you a good picture of the hard parts of the skeleton. Ultrasound images and other scans also let you see the soft tissues. I check to see whether the images I produce are good quality, and then I send them to the specialist who asked for the photo, scan or image.

If someone has swallowed an object down the wrong way, a lung specialist may ask for a scan or an X-ray to be made of the chest. In an X-ray of the lungs, the bones of the ribcage are clearly visible, but the lungs

themselves are less clear. The trachea and the bronchi can however still be seen. The smaller bronchioles can be seen as thin lines, but the alveoli are not visible. Hard objects can be seen well on X-rays, but if a small and soft object is involved, it is better to make a scan. In a scan, a large number of images are made. A computer then merges all the images, so that a three-dimensional representation can be produced. The scan is also good at showing hard objects. Because a scan is more expensive than an X-ray, we still usually make an X-ray first.”



▼ **Fig. 16** Schematic drawing of the windpipe and part of the oesophagus.



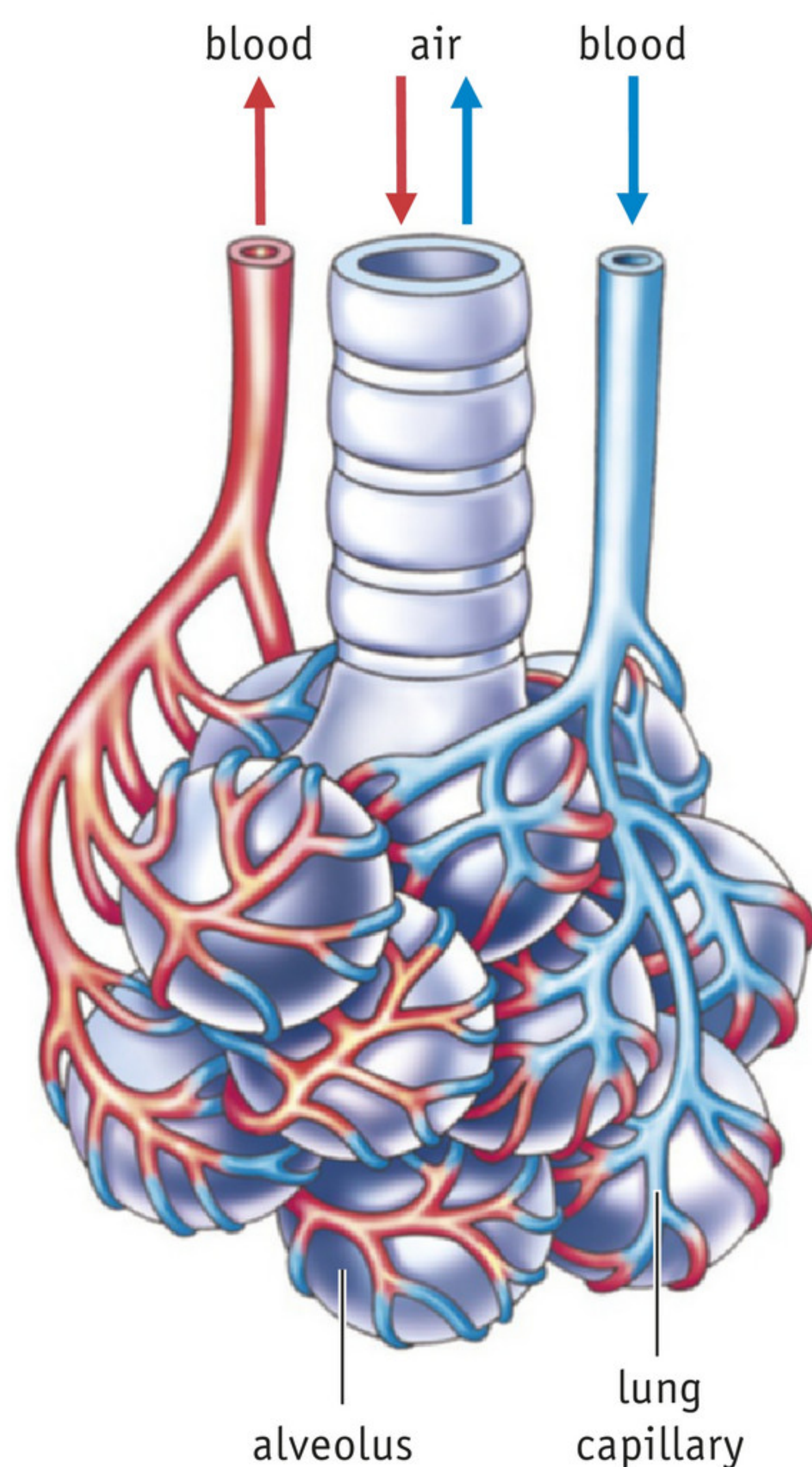
WINDPIPE AND BRONCHI

The windpipe or trachea is a hollow tube that is connected to the lower part of the larynx. The wall of the windpipe has horseshoe-shaped **cartilage rings** around it to make sure it is always open and cannot collapse (see figure 16). The windpipe splits into two branches called the bronchi. The walls of the bronchi also have cartilage rings. The bronchi then divide into smaller and smaller tubes called bronchioles. The walls of the smallest bronchioles have small muscles rather than cartilage rings. At the ends of the bronchioles are the alveoli. The walls of the windpipe, bronchi, bronchioles and alveoli are covered with a mucous lining. Cilia are continuously sweeping the mucus towards the pharynx where it is swallowed.

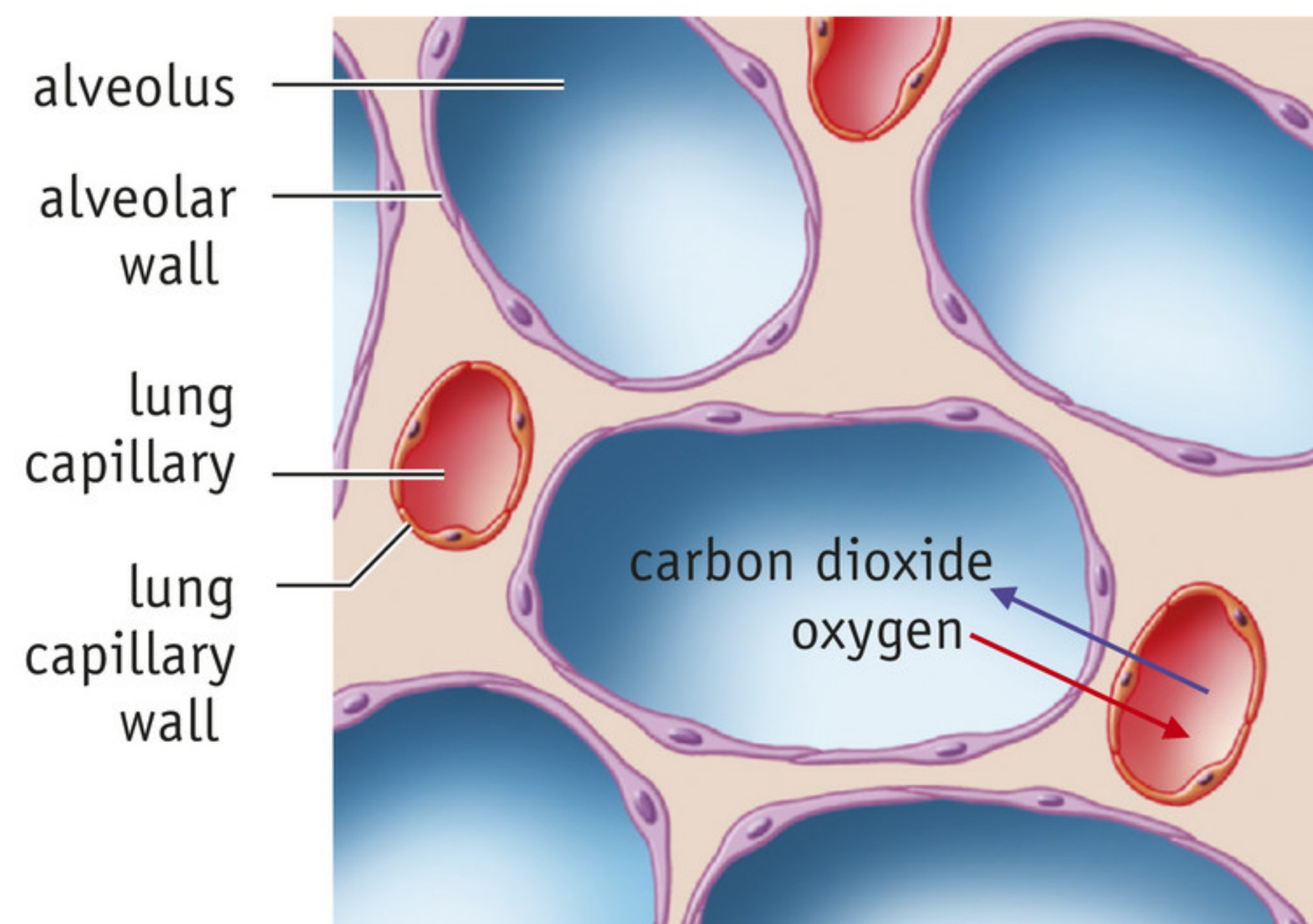
ALVEOLI

At the ends of the bronchioles, the bunches of alveoli are surrounded by a network of tiny blood vessels called the **lung capillaries** (see figure 17). The walls of lung capillaries and alveoli are extremely thin. The surface area of all your alveoli taken together is about half a tennis court. Because the walls are very thin and the surface area very large, **gas exchange** between the air in the alveoli and the blood in the lung capillaries can take place rapidly (see figure 18).

▼ **Fig. 17** Alveoli with lung capillaries (schematic).



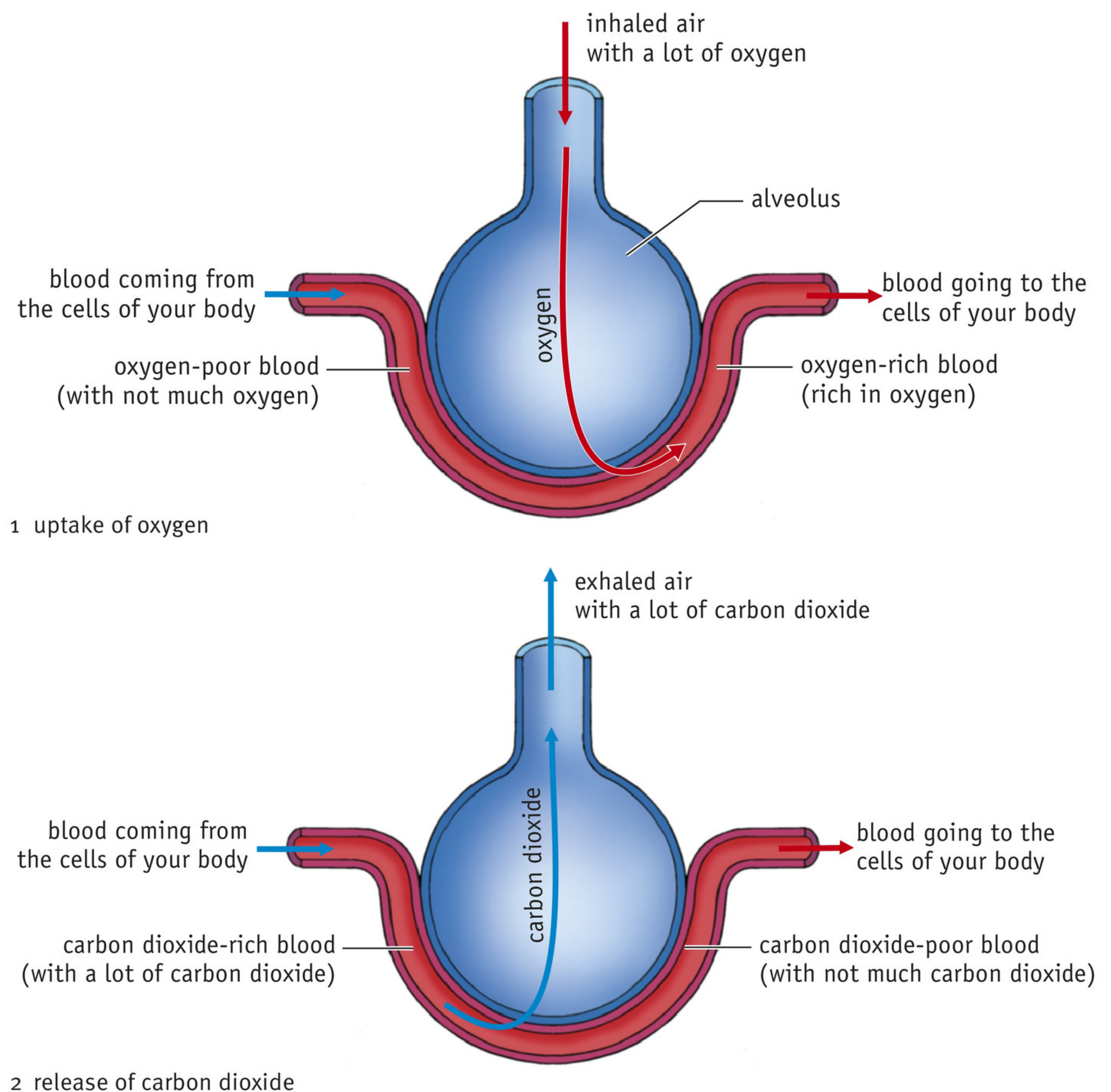
▼ **Fig. 18** Gas exchange in the lungs (schematic).



In the alveoli, oxygen from the air goes into the blood in the lung capillaries. The blood transports the oxygen to all the body's cells, where it then takes up carbon dioxide and carries it to the lungs. In the lungs, carbon dioxide from the blood passes from the lung capillaries into the air in the alveoli. The blood flowing to the alveoli is **oxygen-poor** and **carbon dioxide-rich**. Blood flowing away from the alveoli is **oxygen-rich** and **carbon dioxide-poor** (see figure 19).

WB EXERCISES 18 TO 20, PAGE 18

▼ **Fig. 19** Gas exchange in the lungs (schematic).



5 Breathing

In your lungs, oxygen from the air is absorbed into the bloodstream and carbon dioxide is passed from the blood to the air. The air in your lungs therefore needs to be refreshed continuously. This is done as you inhale and exhale. There are two ways of breathing in and out: with the chest muscles and with the abdominal muscles.

WB EXERCISE 21, PAGE 20

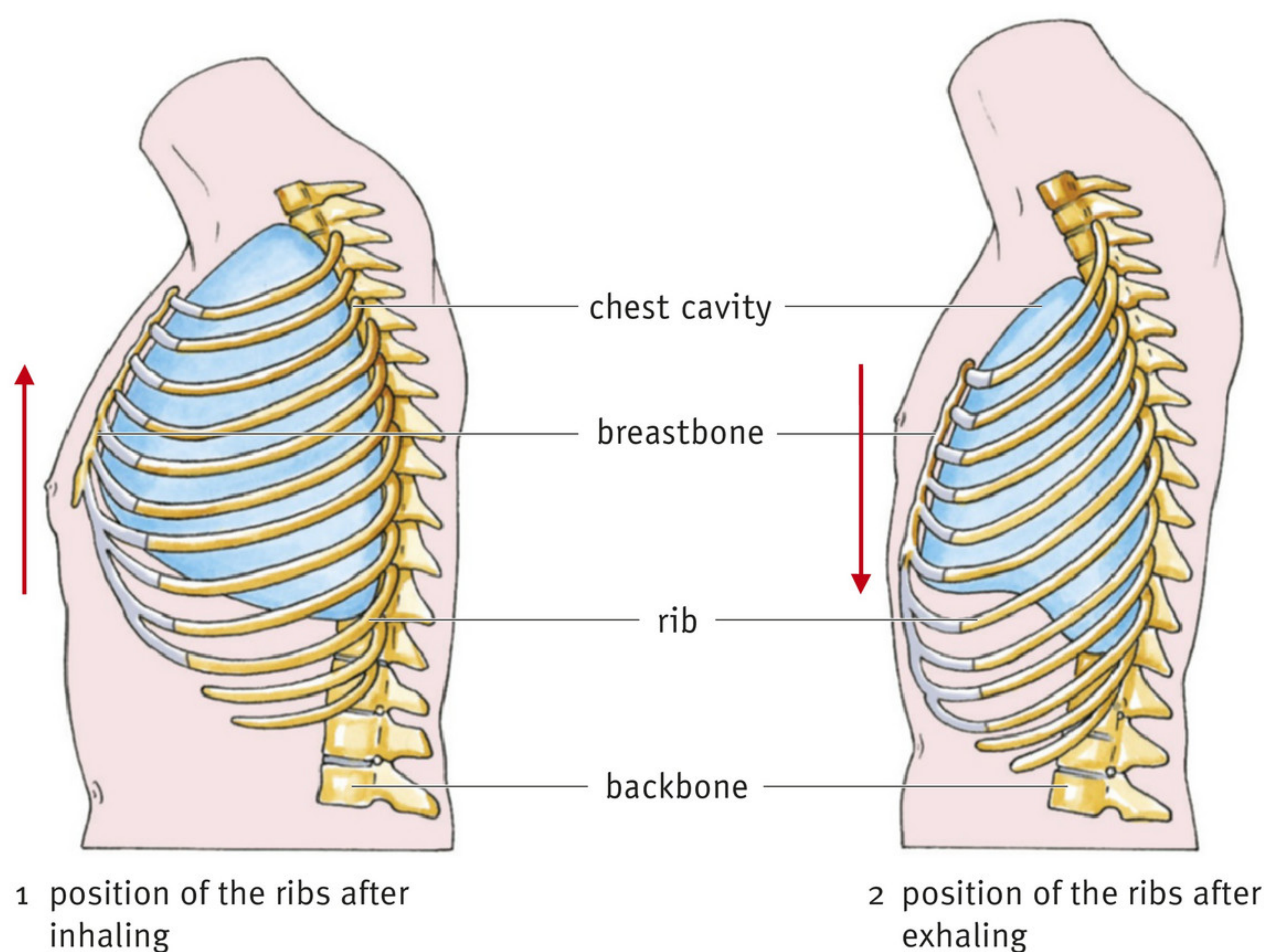
THORACIC BREATHING (CHEST BREATHING)

In thoracic breathing (chest breathing), the ribs and breastbone move. The ribs are attached to the backbone by joints. They are also attached to the breastbone (sternum) by cartilage. These two joints make it possible for the ribs and the breastbone to move.

When you **inhale**, your ribs and breastbone move **upwards** (see figure 20.1). This makes your chest cavity larger. Your lungs are made to expand. Because your lungs expand, air is drawn into them: you breathe in.

When you **exhale**, your ribs and breastbone move **downwards** (see figure 20.2). This makes your chest cavity and lungs smaller again. Making your lungs smaller means that air is forced out of them: you breathe out.

► **Fig. 20** Thoracic breathing or chest breathing (schematic).



ABDOMINAL BREATHING (DIAPHRAGMATIC BREATHING)

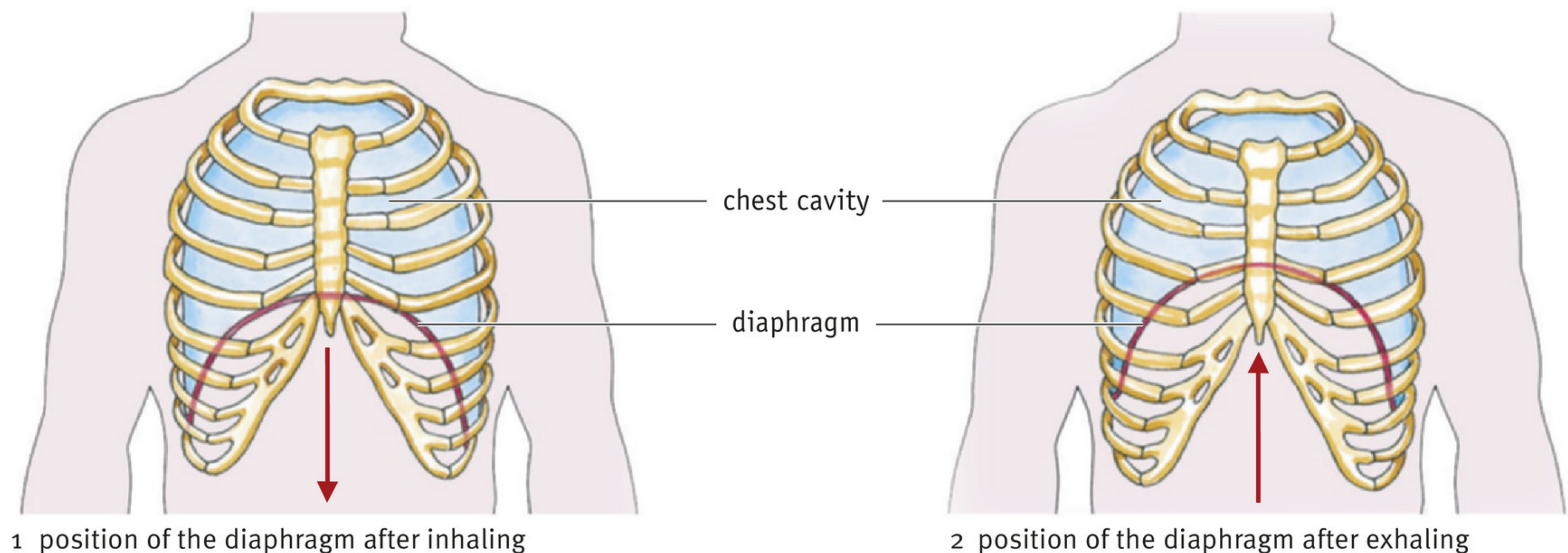
In abdominal breathing (diaphragmatic breathing), the diaphragm and the abdominal wall move. The **diaphragm** is a tough, muscular membrane that divides the thoracic cavity (chest cavity) from the abdominal cavity. The diaphragm can move up and down.

When you **inhale**, your diaphragm moves **downwards** (see figure 21.1). This makes your thoracic cavity larger and your abdominal cavity smaller. Because your thoracic cavity is becoming larger, your lungs are made to expand and air flows into them: you breathe in. Because the abdominal cavity is being made smaller, the organs in your abdominal cavity are pushed away. The only direction they can go in is forwards and so you can feel your abdominal wall moving forwards.

When you **exhale**, your diaphragm moves **upwards** (see figure 21.2). Your chest cavity and lungs get smaller. Air is therefore forced out: you breathe out. There is then room again in the abdominal cavity for the organs and you can feel your abdominal wall returning to its normal position.

WB EXERCISES 22 TO 24, PAGE 20

▼ **Fig. 21** Diaphragmatic or abdominal breathing (schematic).



6

Healthy airways

Various factors can cause your lungs and airways to function less well. You will notice that as shortness of breath, frequent coughing attacks, etc. The cause may be a disease of the respiratory system, such as **asthma**. The cause can also be that you have unintentionally breathed in harmful substances (for instance because of air pollution). Or it may be that you are highly sensitive to particular substances in the Inhaled air. That is the case in some **allergies** such as **hay fever**. Finally, there are also people who deliberately breathe in harmful substances, for example by **smoking**. This can give them COPD. COPD stands for Chronic Obstructive Pulmonary Disease.

ASTHMA

Asthma is a chronic lung condition. Chronic means that the condition will not go away. In asthma, you may be very short of breath. That shortness of breath mostly starts suddenly and we then call it an asthma attack. An attack is caused by specific triggers, such as dust in the air, tension or stress. An asthma attack can be very frightening because you feel that you are suffocating.

The walls of the smallest branches of the bronchi (the bronchioles) have small muscles. In an asthma attack, these muscles contract. This makes the airways narrower and it is more difficult to breathe. This makes you feel short of breath. Sometimes there is nothing more to it than the feeling of shortness of breath, but that does not make it any less frightening (see figure 22).

COPD

COPD (Chronic Obstructive Pulmonary Disease) is chronic inflammation of the airways, usually caused by smoking but sometimes by inherited conditions. The inside of the airways is covered with a mucous lining. Tobacco smoke causes inflammation, making the lining swell up and produce more mucus. The smallest bronchioles in particular can get blocked up. The alveoli can be damaged as well. This is called emphysema.

COPD patients are short of breath, have to cough a lot and sometimes cough up mucus. Everyday things like going up stairs can be more difficult.

WB EXERCISE 25, PAGE 23

▼ Fig. 22

Asthma on the rollercoaster

In 2010, Dutch researchers Simon Rietveld and Ilja Beers won a prize for a piece of research that first makes you laugh and then gets you thinking. They were investigating the effect of 'healthy excitement' on asthma. Healthy excitement is for instance the tension that a child feels before their birthday. According to the researchers, this is the same kind of tension that you experience before a ride on a rollercoaster. Healthy excitement can make people forget that they have asthma.

To investigate this, they got twenty-five students with asthma and fifteen who do not suffer from asthma to take a ride on a rollercoaster. Before the ride, the students were a little bit nervous. The ones who had asthma complained that they were a bit short of breath. Their nervousness was apparent for instance from their elevated heart rate, but they had no symptoms of an asthma attack. After the ride on the rollercoaster, the students were happy and were enjoying themselves a lot. The ones who had asthma were now no longer complaining about shortness of breath, although their lung function did turn out to be reduced. The ride on the rollercoaster had caused an asthma attack, but the students hadn't noticed it.

According to the researchers, people with asthma may unconsciously think that they cannot have asthma attacks if they are feeling good, because they feel unwell during asthma attacks. The converse could then also be true. If they are not feeling good, this could be because they are having an asthma attack and therefore they feel short of breath.

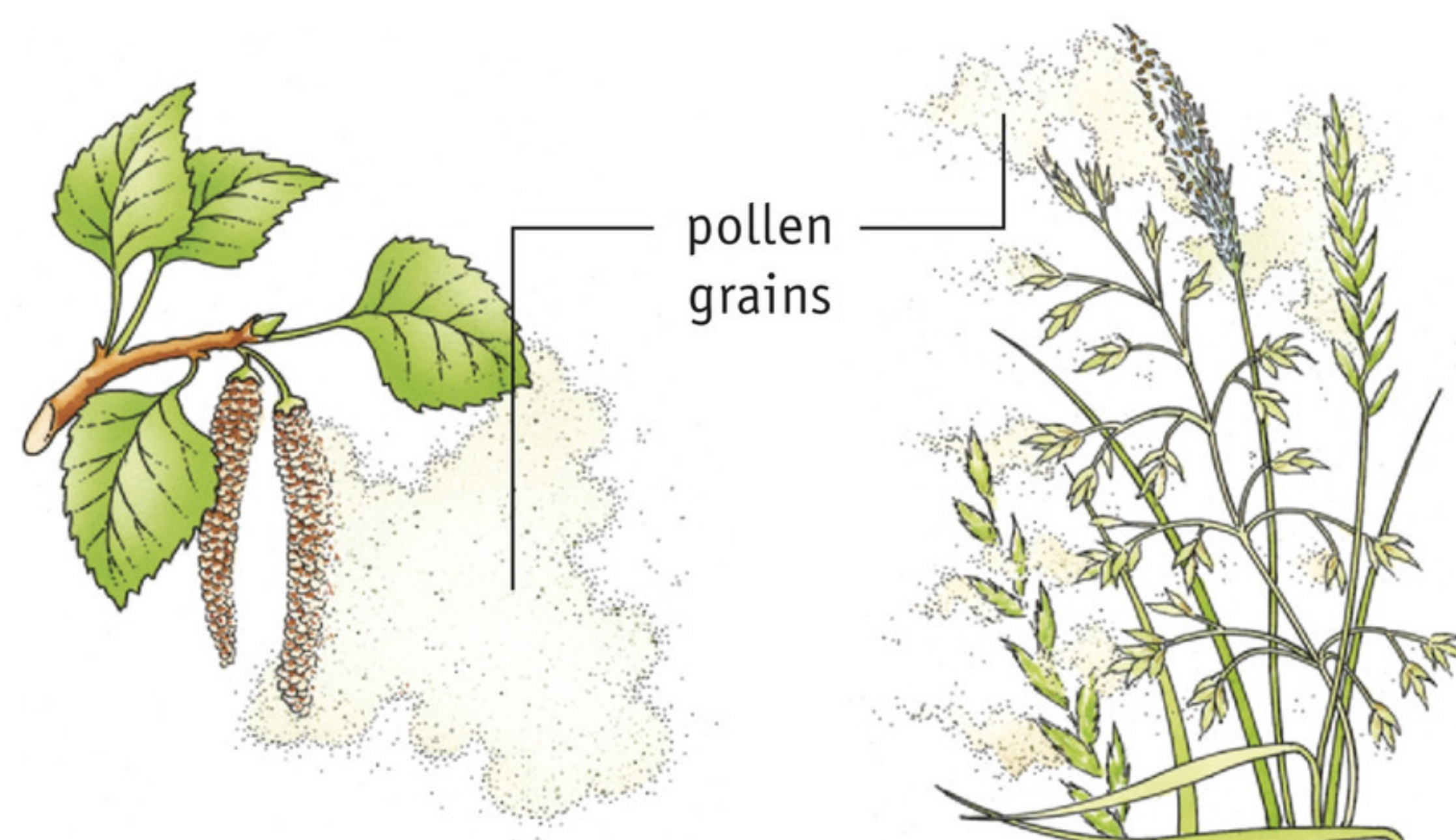
A similar effect can be seen in hay fever sufferers who start sneezing when they see a grassy area on the television. These people are not faking it. Their bodies have linked the grass and the response to it together.



HAY FEVER

In part 1, you learned that wind-pollinated flowers produce large numbers of lightweight pollen grains that are blown away by the wind. There are some days in the spring and summer when the air is full of pollen (see figure 23). You then breathe that pollen in. The pollen grains will then stick to the mucous lining in your airways.

▼ Fig. 23 Pollen.



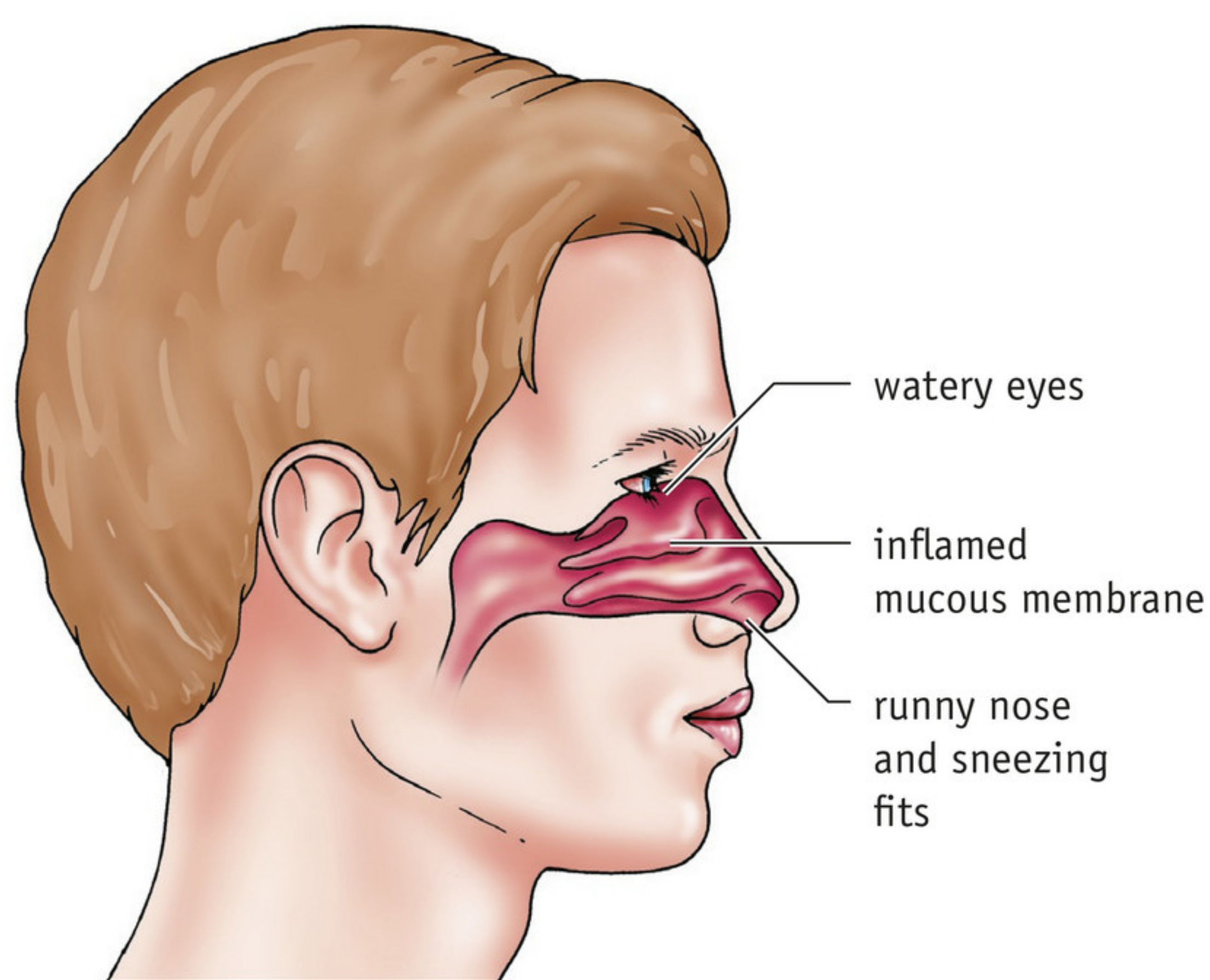
1 mostly in the spring: pollen from trees and shrubs

2 mostly in the summer: pollen from grasses and herbaceous plants

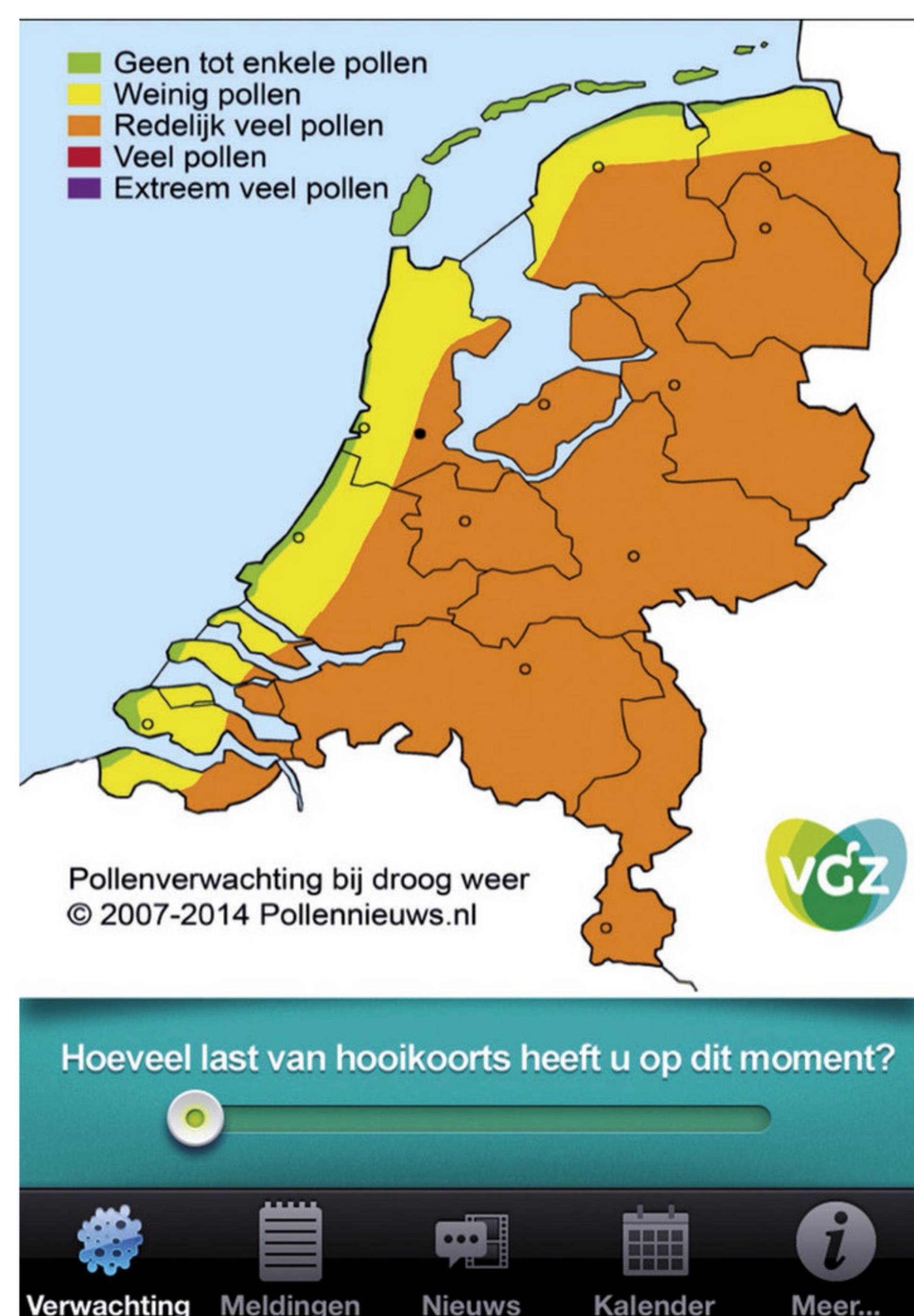
Some people are unable to cope when the pollen of certain plants gets into contact with the mucous membranes of their airways. These people suffer from **hay fever**. They get a burning or itchy feeling in the nose, throat and eyes (see figure 24).

People with hay fever sometimes keep sneezing for hours at a time. For them, it is a good idea if they avoid pollen as much as possible. Information about how much pollen is in the air can be found on the TV, radio and Internet. You can also download an app with information about pollen and hay fever (see figure 25).

▼ **Fig. 24** The symptoms in hay fever.



▼ **Fig. 25** Information about pollen in an app on your mobile phone.



▼ Fig. 26 An allergic skin rash.



ALLERGY

Hay fever is the commonest form of allergy. An **allergy** is when you are hypersensitive to particular substances. When you breathe these substances in or take them in with your food, you get **allergic reactions**.

Figure 26 shows you a skin rash as a result of an allergy. Other examples of allergic reactions are a burning sensation, itching and inflammation. You may be allergic to all kinds of substances, such as household dust, animal hairs, certain substances in food or particular chemicals in makeup. A specialist is often needed to find out exactly what someone is allergic to (see figure 27).

WB EXERCISES 26 AND 27, PAGE 23

▼ Fig. 27

Allergologist

“Hallo! I’m Vicki and I’m an allergologist. After my medical training, I got more and more involved in allergies. I found it so intriguing that I applied for a training place as a junior allergologist at the teaching hospital in Groningen. And I was lucky enough to be accepted. The first part of the course consisted of internal medicine. That is a specialist field involved with diseases of the internal organs. That was followed by two years specialising in allergology. During my specialisation, the wards I worked on included lung diseases, ENT (ear, nose and throat) and dermatology (skin diseases).

I often get patients referred to me with complaints that the GP thinks might be being caused by an allergy. Depending on the symptoms, I will carry out one or more tests. I may for instance test people's responses to foods or to the inhalation of various substances. I often carry out skin tests to determine what somebody is allergic to.

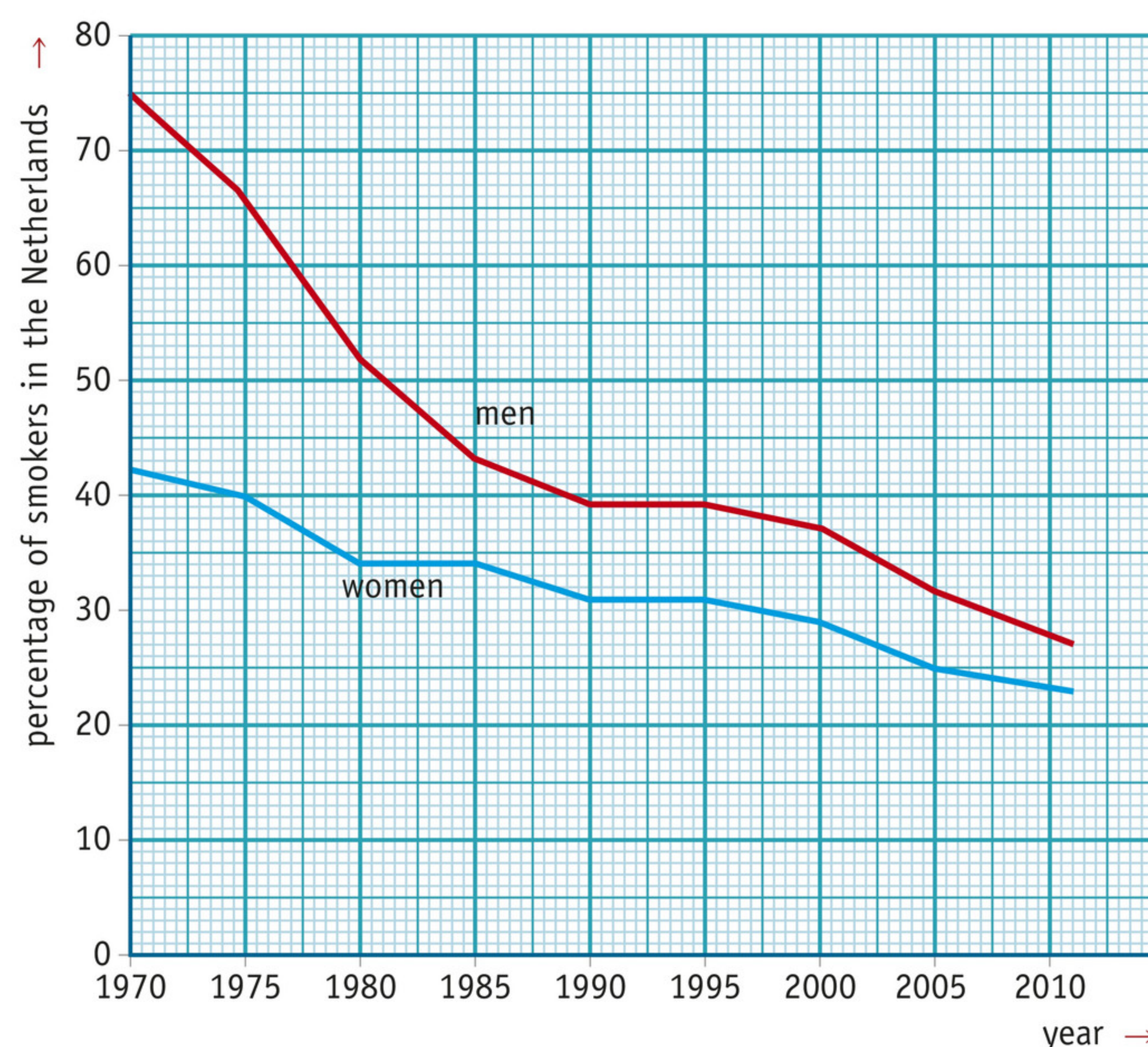
After an allergy has been diagnosed, I give recommendations about learning to living with it. The key thing in that advice is usually that people should avoid the substance that triggers the allergic response. Sometimes I also prescribe medicines.



7 Smoking

Information campaigns about smoking have ensured that everyone now knows that smoking is bad for your health. People who smoke do not live as long as non-smokers. Smoking can give you lung cancer and cardiovascular diseases. That information, coupled with price rises, has ensured that the number of people who smoke has fallen sharply. Nevertheless, about a quarter of the Dutch population still smoke (see figure 28). Smoking causes lung diseases. The two main ones are lung cancer and COPD. Every year, about 5000 people die of COPD because they smoke and about 8000 die of lung cancer.

► **Fig. 28** Smokers in the Netherlands in the period from 1970 to 2012 (people aged 15 and older from 1989 onwards).



THE COMPOSITION OF TOBACCO SMOKE

Tobacco smoke is a mixture of gases and tiny droplets of tar. There are more than 4000 different substances in tobacco smoke, many of them harmful. At least 40 of these substances are known to be carcinogenic (causing cancer). Many of the carcinogens are in the tar droplets. Other substances that are known to be harmful include nicotine and carbon monoxide.

Nicotine is the substance that gets people addicted to smoking. The effects of nicotine are both psychological and physical. Smokers get used to having a certain amount of nicotine in their bodies. When the level of nicotine in their bodies goes down, they feel that they badly need a cigarette. When they light one, the level of nicotine in their bodies is topped up again. Nicotine increases the heart rate and blood pressure. This is why more smokers die of cardiovascular disease (heart conditions) than non-smokers do.

▼ Fig. 29 Smoking damages the lungs.



The **tar** that you breathe in along with the tobacco smoke harms the insides of your airways (see figure 29). The cilia get damaged, making it more difficult for the mucus to be transported away. People who smoke cough a lot ('smoker's cough') and they are more likely to get infections of the airways. The substances that are in the tar can cause cancer. Tar also causes the brown deposits on the fingers and teeth of smokers. In areas where people smoke a lot, you can often see a brown deposit of tar on the wallpaper, the curtains and the ceiling. The substances in the smoke also affect the taste buds and the olfactory centre. This means that smokers are less well able to taste and smell.

The amounts of nicotine and tar in one cigarette are stated on the packet. Because the smoke affects the lungs, they become less able to absorb oxygen. You become less fit as a result.

Carbon monoxide is an odourless gas. When you breathe in **carbon monoxide**, your blood is less able to transport oxygen. This also makes you less fit. Carbon monoxide is also released during combustion in a boiler or water heater. This can happen above all if the ventilation is poor (see figure 30).

Smoking also increases the risk of all kinds of other conditions, such as eye diseases, intestinal problems, dementia and rheumatism.

▼ Fig. 30

Saved just in time from carbon monoxide poisoning

At about quarter past twelve on Sunday afternoon, two people in Den Bosch became unwell as a result of carbon monoxide poisoning. The residents raised the alarm themselves, and so the police were quickly on the scene. They were taken to hospital by ambulance. It is thought that high concentrations of carbon monoxide were released because a central heating

boiler was not working properly. Because humans cannot smell this gas and people do not recognise the symptoms, this situation regularly turns out badly. The symptoms of carbon monoxide poisoning are headache, nausea, dizziness and fatigue. Lengthy exposure can result in loss of consciousness or even death because of lack of oxygen in the brain.

▼ Fig. 31 Warnings on tobacco products.



The smokers are not the only ones who inhale the harmful substances. If you are in an environment where people are smoking, you inhale the smoke of the burning cigarettes and the smoke that is exhaled again by others. This is referred to as **passive smoking** or **second-hand smoking**. As a result, non-smokers can get the same diseases as smokers. Passive smoking in children can cause problems with their airways. They get colds more often, their lung function is poorer and they have asthma more often.

MEASURES TO TACKLE SMOKING

Various measures have been taken in the Netherlands and in Europe as a whole to tackle smoking. One of those measures is increasing the price by taxing tobacco more heavily. This tax is called a 'duty'. To discourage smoking further, there have been warnings on cigarette packets and rolling tobacco since 2002 (see figure 31). There are a total of fourteen of these warning texts. Tobacco companies are no longer allowed to advertise and tobacco products may not be sold to people aged under 18.

To protect people against passive smoking, there is now no smoking in public spaces, on public transport, at work and in schools.

SO WHY DO PEOPLE SMOKE?

Smoking is an **addiction**. Particularly among younger people who start with just the occasional cigarette, the need for nicotine builds up very quickly. A smoker will then want a cigarette more and more often. They are said to be **psychologically dependent**.

The smoker also keeps needing more and more nicotine to feel comfortable. This is called **habituation**.

It then becomes more and more difficult to stop. If the smoker tries to stop, their body then starts to protest: they are said to be **physically dependent**.

The complaints that someone gets when they stop smoking are called **withdrawal symptoms**. These can for instance include headaches, agitation, anxiety, depression, intestinal problems and weight gain. It is a difficult period, but those symptoms do then disappear after a while.

The best thing is never to start smoking, of course. Then you do not have to stop. But young people are often easily tempted, particularly at a party or when they are on holiday. If your friends offer you a cigarette, it can be difficult to say no. And it gets even trickier if people are drinking alcohol as well. Figure 32 gives you a number of tips that you can use to help you say no to a cigarette.

WB EXERCISES 28 TO 30, PAGE 26

▼ Fig. 32

TIPS FOR REFUSING A CIGARETTE

Refuse

Say clearly that you do not smoke. If someone offers you a cigarette, you can for instance say, "No, you know I don't smoke."

Ignore

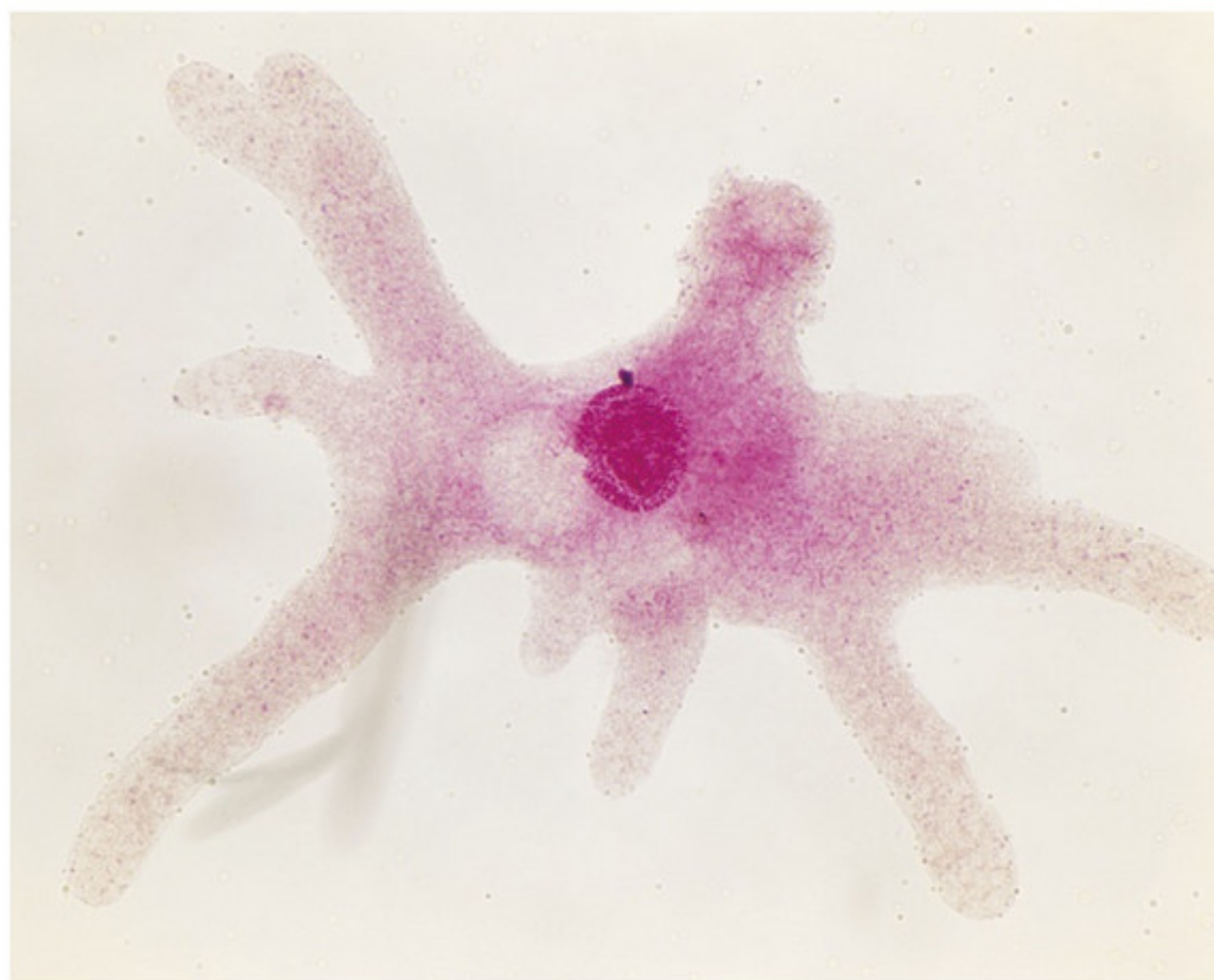
You can also ignore someone who offers a cigarette: pay it no attention and just keep on talking about something else. The message will get through after a while.

Leave

You can also simply walk away. If you do not fancy smoking or standing in somebody else's smoke, you can also just leave. Walk off somewhere else, or go away with somebody else who is leaving. Maybe the smoker will then even start thinking about their own habit.

8 Breathing in animals

▼ **Fig. 33** An amoeba (stained, 100× magnification).



All organisms absorb substances from and emit substances to their surroundings. It makes no difference whether the organism consists of a single cell or a vast number. In part 1, you learned that an amoeba is a single-celled organism (see figure 33). In single-celled organisms, respiration takes place through the cell membrane. The surface area of the cell membrane is big enough to absorb enough oxygen and to release enough carbon dioxide. Single-celled animals therefore do not need special respiratory organs.

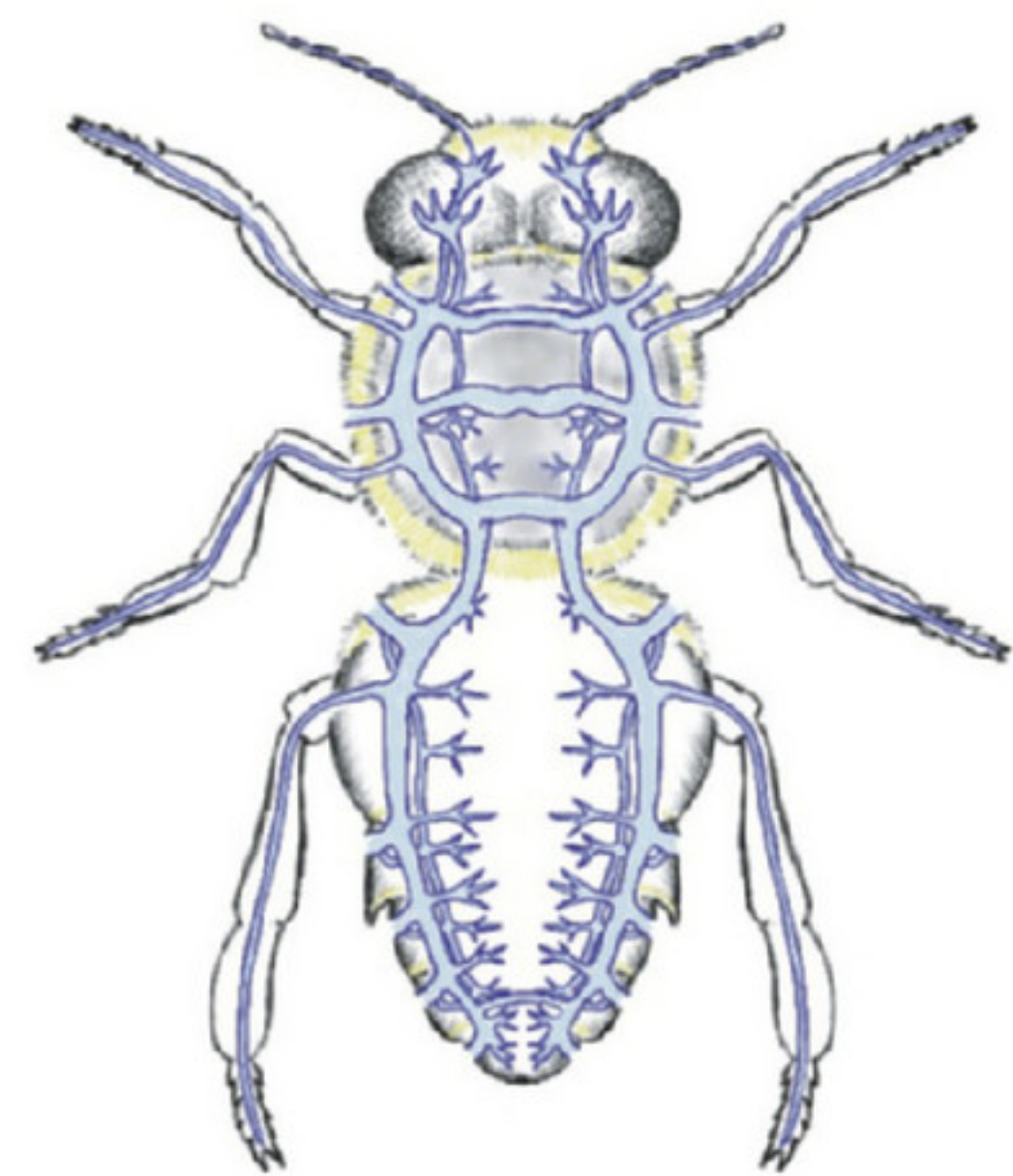
The surface area of animals that are made up of large numbers of cells is not big enough to absorb enough oxygen and to release enough carbon dioxide. On top of that, the skin of many animals is impermeable. All these animals need special respiratory organs that let them absorb oxygen and get rid of carbon dioxide. Examples of such organs are tracheae, gills and lungs. You can learn more about gills in extension 2.

TRACHEAE

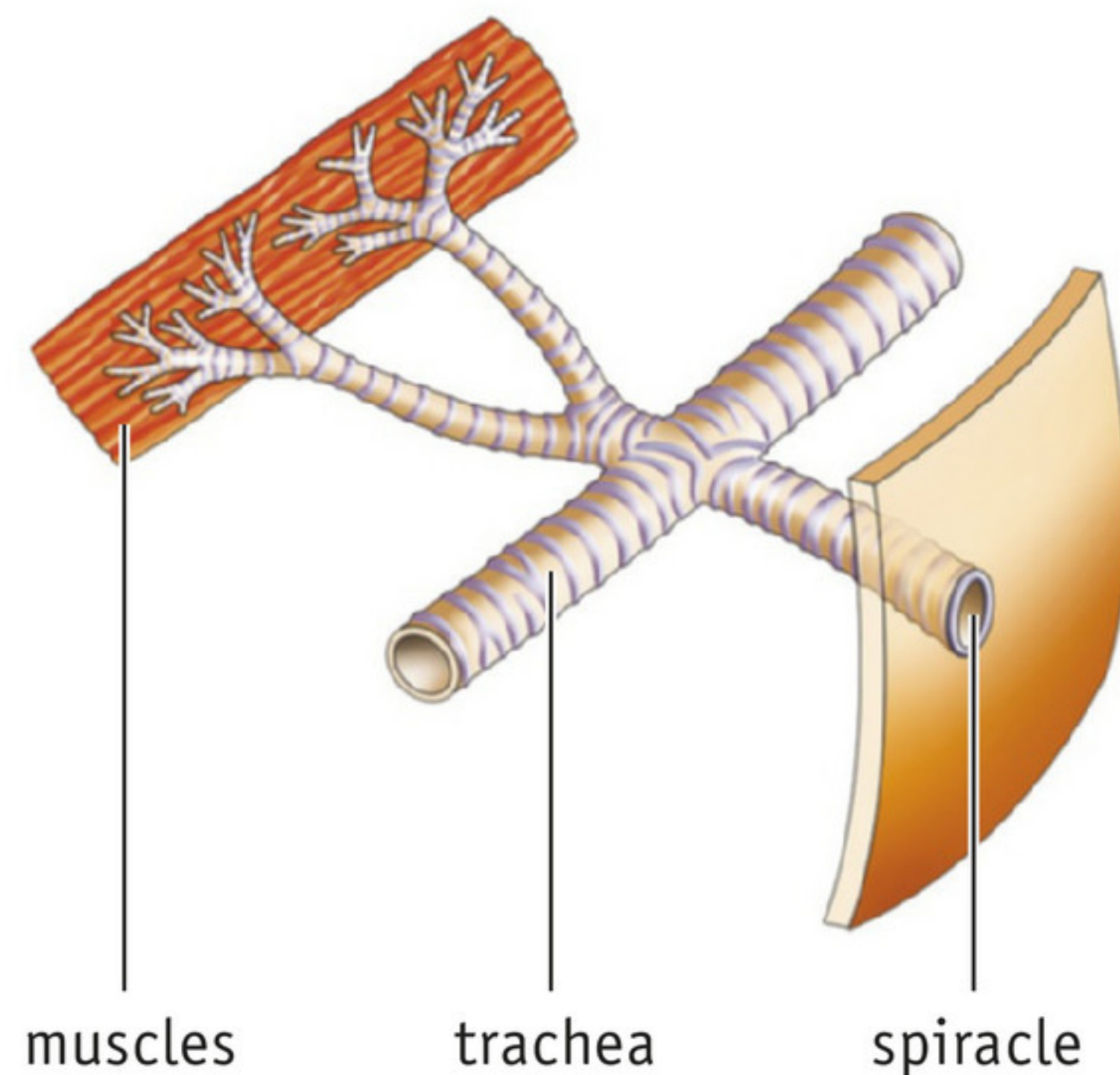
Insects have tracheae. **Tracheae** are heavily branched tubes inside the body of the insect (see figure 34). There are openings that let air into the system of tracheae. These openings are called **spiracles**. The smaller branches of the tracheae end up everywhere in the body. Taken as a whole, all the branches have a large surface area, so that gas exchange can take place quickly. In many species of insects, the spiracles are located largely in the abdomen. These insects make a kind of pumping movement with their abdomen, moving it back and forth so that the air in the tracheae is refreshed. The larvae of some species of insects such as mosquitoes develop in water. These larvae have protrusions that ensure that the system of tracheae remains in contact with the air (see figure 35).

WB EXERCISES 31 AND 32, PAGE 28

▼ **Fig. 34** Tracheae in an insect.



1 system of tracheae (schematic)



2 trachea with branches (schematic)

▼ **Fig. 35** Spiracles in a caterpillar.



spiracle

▼ **Fig. 36** The larva of a mosquito.



9 Vital capacity

Not everyone's lungs are the same size. The volume of the lungs is smaller for children than for adults. The amount of air inhaled and exhaled with each breath varies too.

When an adult is breathing normally, about 0.5 litres is inhaled and exhaled with each breath. This amount of air is referred to as the **tidal volume**. About 150 mL of air gets no further than the bronchi, the trachea, the throat and the nasal cavity. This is referred to as the **dead space**. The air in the dead space is not involved in the gas exchange in the alveoli. This air is expelled during the next inhalation without having been used.

By breathing in really deeply, an adult can on average inhale about an extra 3 litres of air. By exhaling fully, they can on average expel about another 1.5 litres of air. The maximum amount of air that can be breathed in or out per breath is known as the **vital capacity**. You can determine the vital capacity by first breathing in as deeply as possible and then measuring the amount of air expelled when you exhale as fully as possible.

The vital capacity is not the same as the **lung volume** because some air always remains in the lungs. After exhaling deeply, an adult will on average still have about 1.5 litres of air left in the lungs and in the airways. This is known as the **residual volume**.

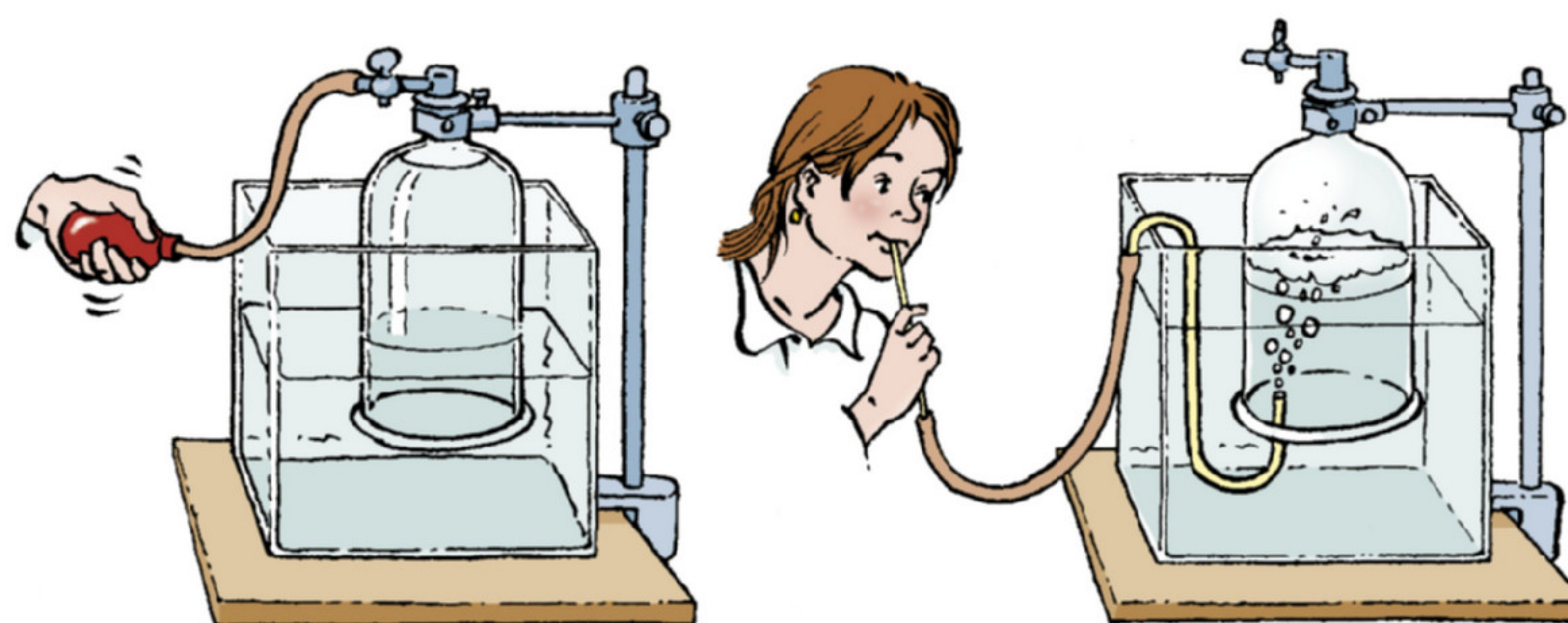
You can measure vital capacity using a spirometer (see figure 37). You can also measure vital capacity using a computer or using the experimental setup shown in figure 38.

▼ **Fig. 37** Measuring vital capacity with a spirometer.



WB EXERCISES 33 AND 34, PAGE 30

▼ **Fig. 38** Experimental setup for measuring vital capacity.



1 removing air from the bell jar

2 exhaling into the bell jar

Summary

OBJECTIVE 1

You must be able to describe combustion and respiration. You must also know how to test for the presence of carbon dioxide.

- Fuel: the substance that is burned.
 - Oxygen is needed if a fuel is to be burned.
- Combustion products: the substances produced during burning.
 - The combustion products when a candle is burned are carbon dioxide and water.
- Combustion releases energy, for example as movement and heat.
- Burning a candle

candle wax + oxygen → water + carbon dioxide + energy

- Indicator: a substance that can be used to demonstrate the presence of another.
 - clear limewater is an indicator for carbon dioxide.
 - The clear limewater goes cloudy if carbon dioxide is added to it.

OBJECTIVE 2

You must be able to name the differences between inhaled and exhaled air.

- Inhaled air consists of 78% nitrogen, 21% oxygen and 1% other gases, including inert gases (noble gases).
 - Dry air contains 0.04% carbon dioxide.
 - The quantity of water in the air can vary.
- The air that you exhale contains:
 - less oxygen;
 - more carbon dioxide;
 - more water vapour.
- The amounts of nitrogen and inert gases in Inhaled and exhaled air are the same.

OBJECTIVE 3

You must be able to describe respiration in cells and explain the relationship with physical activity.

- Respiration takes place in all the cells of an organism.
 - Respiration goes on all the time, day and night.
 - The energy that is released is used for the processes within the cell.

- Diagram describing respiration in a cell:

glucose + oxygen → water + carbon dioxide + energy
(fuel) (combustion products)

- The amount of energy you need depends on the physical effort you are making.
 - You need energy whenever you are doing anything.
 - Energy can be converted from one form into another.
- The greater the physical effort, the more respiration takes place.
 - More fuel is then needed. More waste products are also produced.
 - Organs such as the lungs and heart will then work harder.

OBJECTIVE 4

You must be able to describe the difference in respiration between cold-blooded and warm-blooded animals.

- In cold-blooded animals, the body temperature depends on the temperature of the surroundings.
 - At low temperatures, respiration in the cells is slower. Not much energy is then released.
 - This means that cold-blooded animals are not very active in cold temperatures.
- In warm-blooded animals, the body temperature is constant.
 - the activity of warm-blooded animals depends less on the temperature of their surroundings.
- To keep the body temperature constant, a lot of energy (and therefore a lot of respiration) is needed and loss of heat has to be avoided.
 - warm-blooded animals often have some form of insulation.
 - many warm-blooded animals migrate to warmer areas in the autumn. There are also warm-blooded animals that hibernate.

OBJECTIVE 5

You must be able to name the parts of the respiratory system and their features and functions.

- The respiratory system consists largely of tubes lined with a mucous membrane.
 - Germs and dust particles remain stuck to the mucus.
 - Cilia move the mucus towards the back of the pharynx where it is then swallowed.

- Nasal cavity
 - Nasal hairs stop large dust particles from getting in.
 - The nasal lining warms and moistens the air as it flows in.
 - The olfactory system checks the incoming air.
- Pharynx: this is where the uvula and the epiglottis are.
 - During breathing, the uvula and the epiglottis are open.
 - During swallowing, the uvula closes off the nasal cavity and the epiglottis close off the airway.
 - Choking: the epiglottis does not close the airway off during swallowing.
- Larynx: this is where the vocal cords are.
- Windpipe and bronchi
 - The wall is reinforced by horseshoe-shaped rings of cartilage that keep the windpipe open.
 - The windpipe branches into bronchi, which are also reinforced by cartilage rings.
- Bronchioles: branches of the bronchi.
 - The walls of the smaller bronchioles have muscles.
- Alveoli.
 - In the alveoli, oxygen from the air is absorbed into the blood in the lung capillaries.
 - In the alveoli, carbon dioxide from the blood is passed from the lung capillaries into the air in the alveoli.
 - The blood becomes rich in oxygen and low in carbon dioxide.
 - Gas exchange in the lungs can be rapid because all the alveoli together have a large surface area and because their walls are thin.

OBJECTIVE 6

You must be able to describe how inhalation and exhalation take place.

- In normal breathing, both thoracic breathing and abdominal breathing are used.
 - In thoracic breathing (chest breathing), the ribs and breastbone move up and down.

Inhaling	Exhaling
1 The ribs and the breastbone move upwards.	1 The ribs and the breastbone move downwards.
2 The thoracic cavity becomes bigger.	2 The thoracic cavity becomes smaller.
3 The lungs become bigger.	3 The lungs become smaller.
4 Air flows in.	4 Air flows out.

- In abdominal breathing (diaphragmatic breathing) the diaphragm moves up and down. This makes the abdominal wall move back and forth.

Inhaling	Exhaling
1 The diaphragm moves down (the abdominal wall moves forward).	1 The diaphragm moves up (the abdominal wall goes back).
2 The thoracic cavity becomes bigger.	2 The thoracic cavity becomes smaller.
3 The lungs become bigger.	3 The lungs become smaller.
4 Air flows in.	4 Air flows out.

OBJECTIVE 7

You must be able to describe what the problems are in asthma, COPD, allergies and hay fever.

- Asthma and COPD are chronic lung conditions.
 - Asthma and COPD patients get short of breath and cough a lot.
 - They are very sensitive to dust particles in the air.
 - In asthma, the airways become narrower because muscles in the smallest branches of the bronchi contract.
 - In COPD, inflammation makes the mucous lining swell up; alveoli are sometimes also damaged.
 - COPD is primarily caused by smoking.
- Allergy: hypersensitivity to one or more substances.
 - You may be allergic to e.g. household dust, animal hair, certain substances in foods, etc.
 - Allergic reactions occur when the body comes into contact with these substances.
 - Examples of allergic reactions: skin rash, a burning sensation, itching and inflammation.
- Hay fever: an allergy to pollen grains.
 - Allergic reactions in hay fever: running eyes, inflamed mucous membranes, a runny nose and sneezing fits.
 - If you are allergic to tree pollen, you get hay fever in the spring in particular.
 - If you are allergic to grass pollen, you get hay fever in the summer in particular.

OBJECTIVE 8

You must be able to describe the harmful effects of tobacco smoke on your body.

- Tobacco smoke is a mixture of gases and tiny droplets of tar.
 - Components of tobacco smoke include nicotine, tar and carbon monoxide.
- Nicotine is what gets you addicted to smoking.
 - A smoker's body needs nicotine.
 - When a smoker stops smoking, withdrawal symptoms can occur.
- Tar damages the lungs.
 - The cilia get damaged by the tar.
 - There are substances in the tar that cause lung cancer.
- Carbon monoxide reduces the blood's ability to transport oxygen.
 - Because the blood can transport less oxygen, you are less fit.
- Passive smoking is when you inhale other people's tobacco smoke.
 - Passive smoking is sometimes called second-hand smoking.
- A number of measures have been taken to tackle smoking:
 - Increasing the price by taxing it more heavily.
 - There are warning texts on the packaging of tobacco products.
 - Tobacco products may not be advertised.
 - Tobacco products may not be sold to people aged under eighteen.
 - Smoking in public places and in the workplace is forbidden.
- Smoking is addictive.
 - Habituation, psychological dependency and physical dependency all occur.
 - When a smoker stops smoking, withdrawal symptoms may occur.

EXTRA OBJECTIVE 9

You must be able to describe how gas exchange occurs in various different groups of animals.

- Unicellular organisms: gas exchange through the cell membrane.
- Tracheae are branched tubes of air that terminate everywhere throughout the body.
 - Spiracles: openings that let air flow into the tracheae.
 - Insects have a system of tracheae.

EXTRA OBJECTIVE 10

You must be able to describe the tidal volume, the vital capacity and the lung volume.

- Tidal volume: the amount of air that is breathed in and out at rest.
 - The dead space is the air in the nasal cavity, pharynx, windpipe and bronchi.
- Vital capacity: the maximum amount of air that can be breathed in or out per breath. The vital capacity comprises:
 - the tidal volume;
 - extra air that is inhaled when you draw a deep breath;
 - extra air that is exhaled when you breath out fully;
- Residual volume: the air that remains in the lungs after a deep exhalation.
- Lung volume: the physical volume of the lungs.
 - Maximum lung volume = vital capacity + residual volume.

SKILLS AND COMPETENCIES**BASICS**

- You have learned how to show differences in the levels of carbon dioxide and oxygen in the air.
- You have practised carrying out an investigation.
- You have practised reading graphs.
- You have practised getting information from newspaper articles and folders.

EXTRA

- You have learned how to measure someone's vital capacity.
- You have practised designing an investigation.

The diagnostic test does not include any questions about these competencies/skills.

You have met a radiologist and an allergologist in this unit. You have also seen applications in science and daily practice that use the material from this unit.

Diagnostic test

You can use this test to check for yourself whether you understand and can apply the objectives listed in the summary. Write down the answers on the score sheet in your workbook.

OBJECTIVE 1

Answer the following questions.

Barbara is camping with the Girl Guides. To prepare the food, they have a gas bottle of butane, a gas ring and various pots and pans. They are going to make spaghetti. First, they put a pan of water on the gas ring, which they then light. Once the water is boiling, they put the spaghetti in the pan. Questions 1 to 4 are about this text.

- 1 What substance is being used as the fuel for the cooking?
- 2 During the cooking, combustion takes place in the gas ring.
Which substance from the air is needed for the combustion in the gas ring?
- 3 In what forms is energy released by the combustion in the gas ring?
- 4 The burning fuel produces combustion products. If you pass these combustion products through clear limewater, it turns cloudy.
What combustion product has this shown to be present?

Figure 39 is a diagram representing the combustion of a candle. A number of words have been replaced by numbers. Question 5 is about this diagram.

- 5 Which number shows a fuel?
- 6 What term is used for a substance that can be used to demonstrate the presence of another?

▼ Fig. 39

1 + oxygen → water + 2 + energy (3 and heat)

OBJECTIVE 2

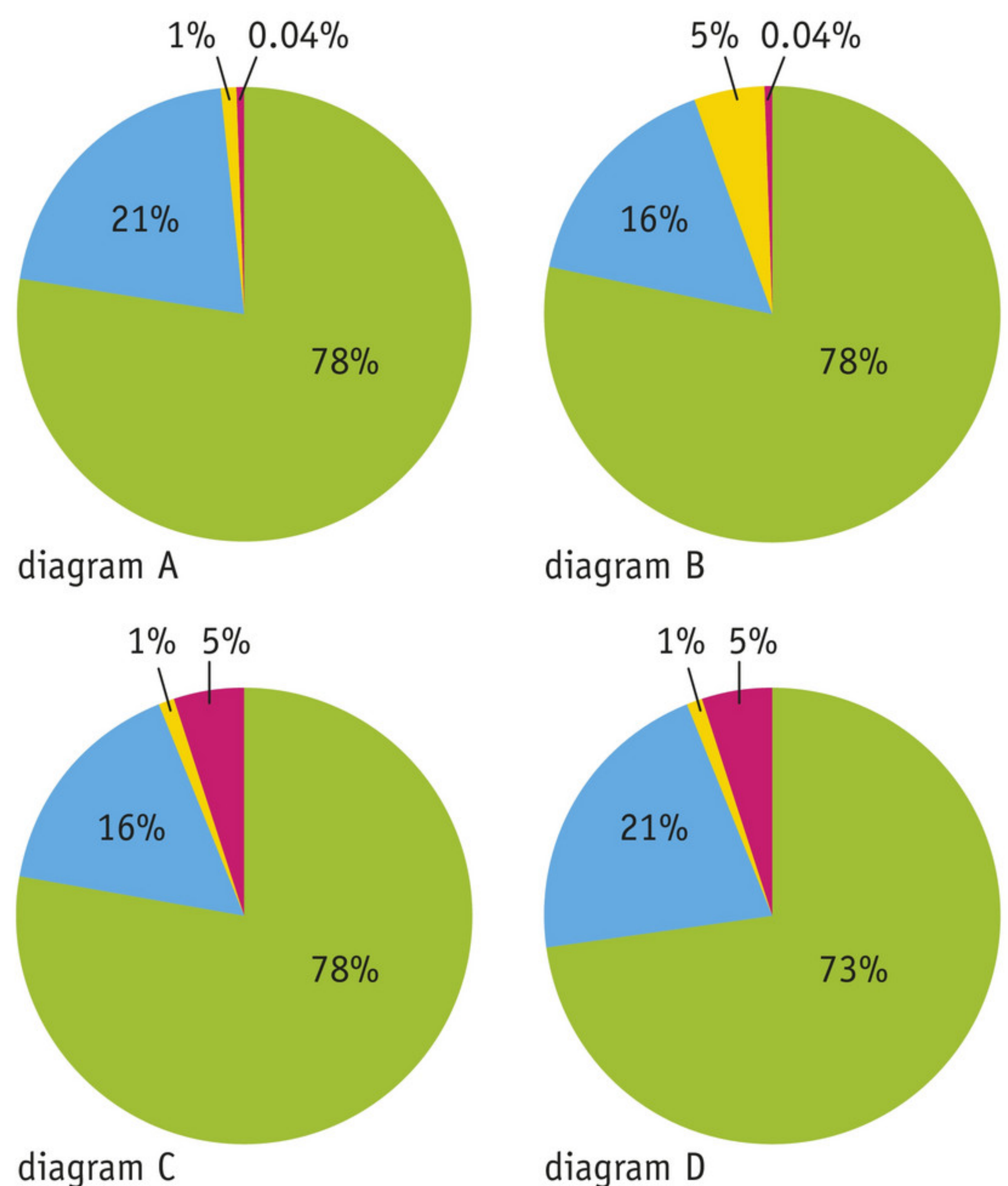
Answer the following multiple choice questions.

- 1 Which gases together make up 99% of the air?
 - A Carbon dioxide and nitrogen.
 - B Carbon dioxide and oxygen.
 - C Nitrogen and oxygen.

- 2 In an experiment, the composition of the air exhaled by a person is determined.
Which diagram in figure 40 could represent the composition of the air exhaled by this person correctly?

- A Diagram A.
- B Diagram B.
- C Diagram C.
- D Diagram D.

▼ Fig. 40



Legend:

● nitrogen ● oxygen ● noble gases ● carbon dioxide

- 3 The presence of water vapour in air can be demonstrated using the test setup shown in figure 41. The low temperature of the ice means that water from the air is left behind in the tubes.
For 15 minutes, someone uses experimental setup 1, breathing in outside air through the mouth and breathing out through the nose.
For 15 minutes, someone uses experimental setup 2, breathing out through the mouth and breathing in through the nose. After 15 minutes of breathing, more water is left in the tube for setup 2 than in the tube for setup 1. The tube for setup 2 has also melted more ice than the tube for setup 1.

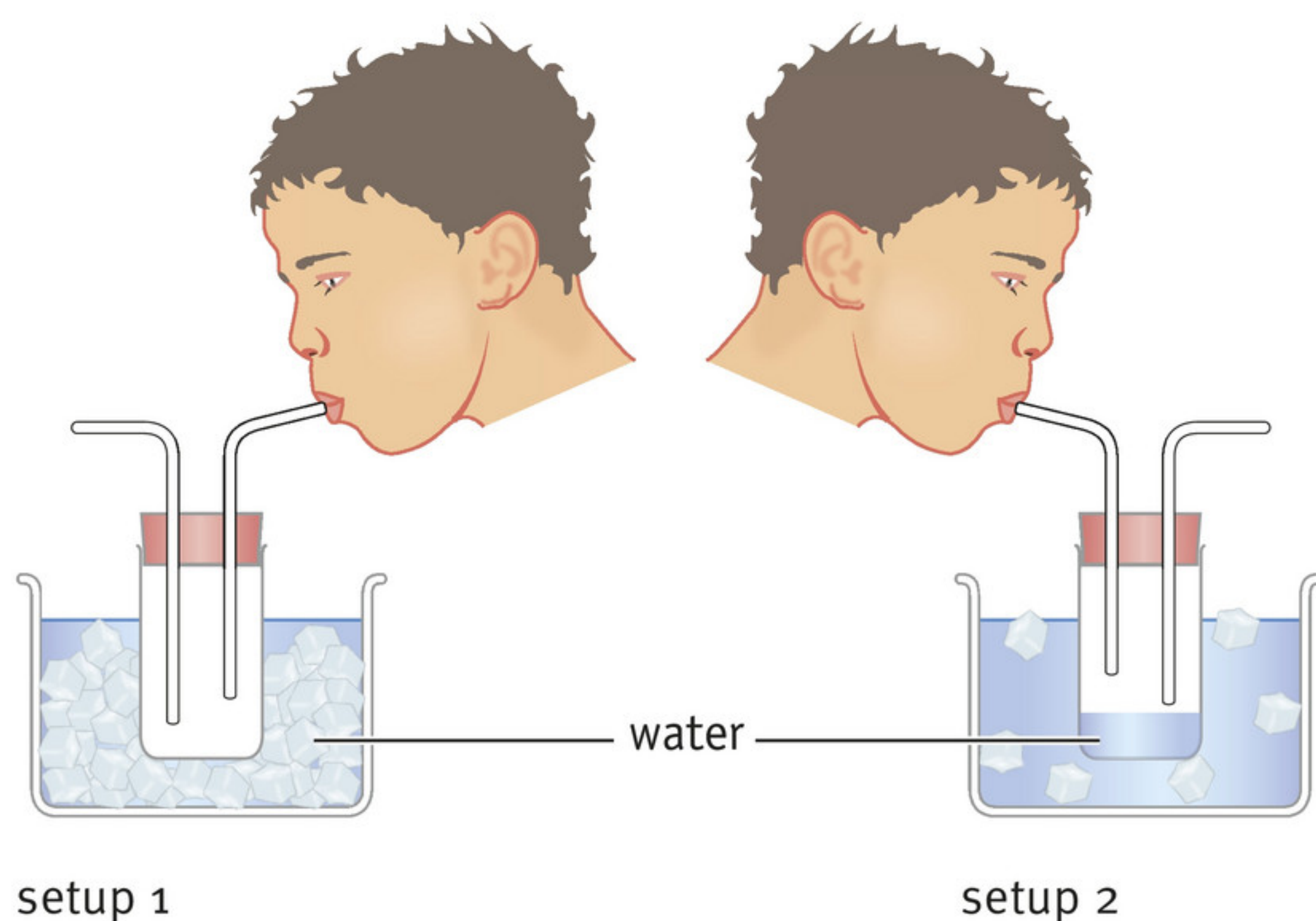
Here are four statements about this experiment:

- 1 Respiration in the body produces water.
- 2 The inhaled air contains less water than the exhaled air.
- 3 The inhaled air is colder than the exhaled air.
- 4 The body temperature is higher than the temperature of the surroundings.

Which of these statements could be a conclusion from this experiment?

- A Only statements 1, 2 and 3.
- B Only statements 1, 3 and 4.
- C Only statements 2, 3 and 4.
- D All four statements.

▼ Fig. 41



OBJECTIVE 3

Answer the following multiple choice questions.

- 1 Petunias are annual plants that can be seen in many gardens (see figure 42). Various varieties can be bought in all sorts of colours. After the plant has flowered, fruits containing seeds develop from the flowers. When the fruits are ripe, the plant dies off. If you collect up the seeds and keep them, you can start sowing them again in January. While the seeds are being stored, some of them will die. Will seeds that are able to germinate use up oxygen? And seeds that are dead?
 - A None of the seeds will use up oxygen.
 - B Only the seeds that are able to germinate will use up oxygen.
 - C Only the seeds that are dead will use up oxygen.

▼ Fig. 42



- 2 Two pupils make statements about respiration in the muscle cells of their bodies. Bridget says that respiration is always taking place in her muscle cells. Chloe says that there is only respiration in the muscle cells when the muscle contracts. Which of them is right?
 - A Neither of them is right.
 - B Only Bridget is right.
 - C Only Chloe is right.
- 3 When you move, certain muscles contract. The temperature of the blood flowing into those muscles is 37°C . Is the temperature of the blood flowing out of these muscles lower than 37°C , equal to 37°C or higher than 37°C ?
 - A Lower than 37°C .
 - B Equal to 37°C .
 - C Higher than 37°C .
- 4 What fuel is generally used inside the cells in the body?
 - A Glucose.
 - B Carbon dioxide.
 - C Oxygen.

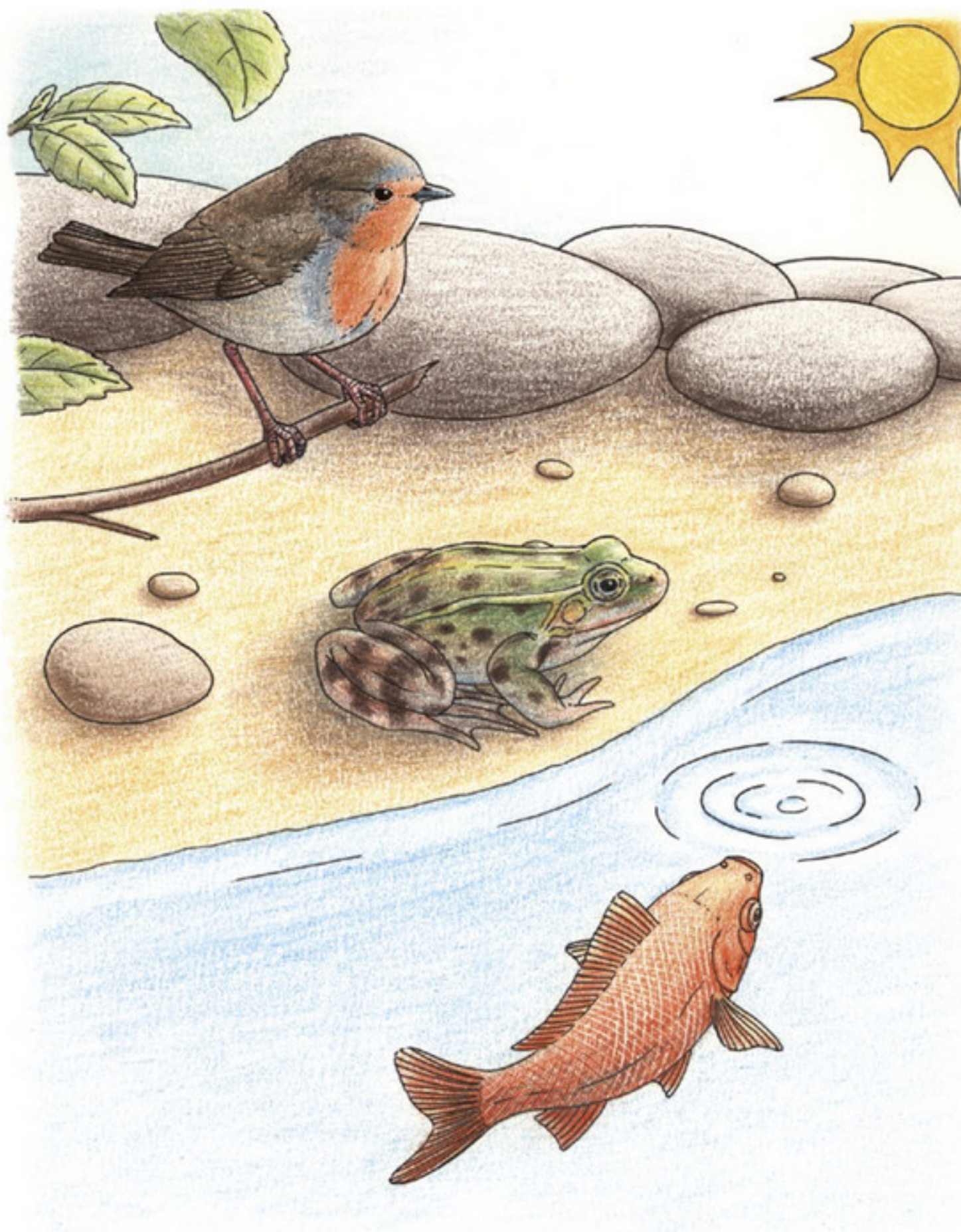
OBJECTIVE 4

One morning in early spring, a frog is sitting in the sun at the edge of a pond. There is a robin close to the frog. There is also a goldfish in the water (see figure 43). The three animals are not moving.

Answer the following multiple choice questions about the animals in figure 43.

- 1 Which of these animals is warm-blooded?
 - A The goldfish.
 - B The frog.
 - C The robin.
- 2 On a sunny spring morning, the temperature of the air will be higher than the temperature of the pond water.
Which animal will then need the least oxygen?
 - A The goldfish.
 - B The frog.
 - C The robin.
- 3 Which animal or animals have a layer of fat under the skin?
 - A Only the goldfish.
 - B Only the robin.
 - C The goldfish and the frog.

▼ Fig. 43

**OBJECTIVE 5**

Answer the following multiple choice questions.

- 1 Where in the body are the vocal cords?
 - A In the bronchi.
 - B In the pharynx.
 - C In the windpipe.
 - D In the larynx.
- 2 A pupil asks his classmates why breathing in through your nose is healthier than breathing in through your mouth.
Judy says it is because breathing through your nose is better at keeping out germs in the inhaled air than breathing through your mouth.

Richard replies that it is because breathing through your nose gets more oxygen into the lungs than breathing through your mouth.

Who is right?

- A Neither of them is right.
- B Only Judy is right.
- C Only Richard is right.
- D Both of them are right.

The following information is for questions 3 and 4.

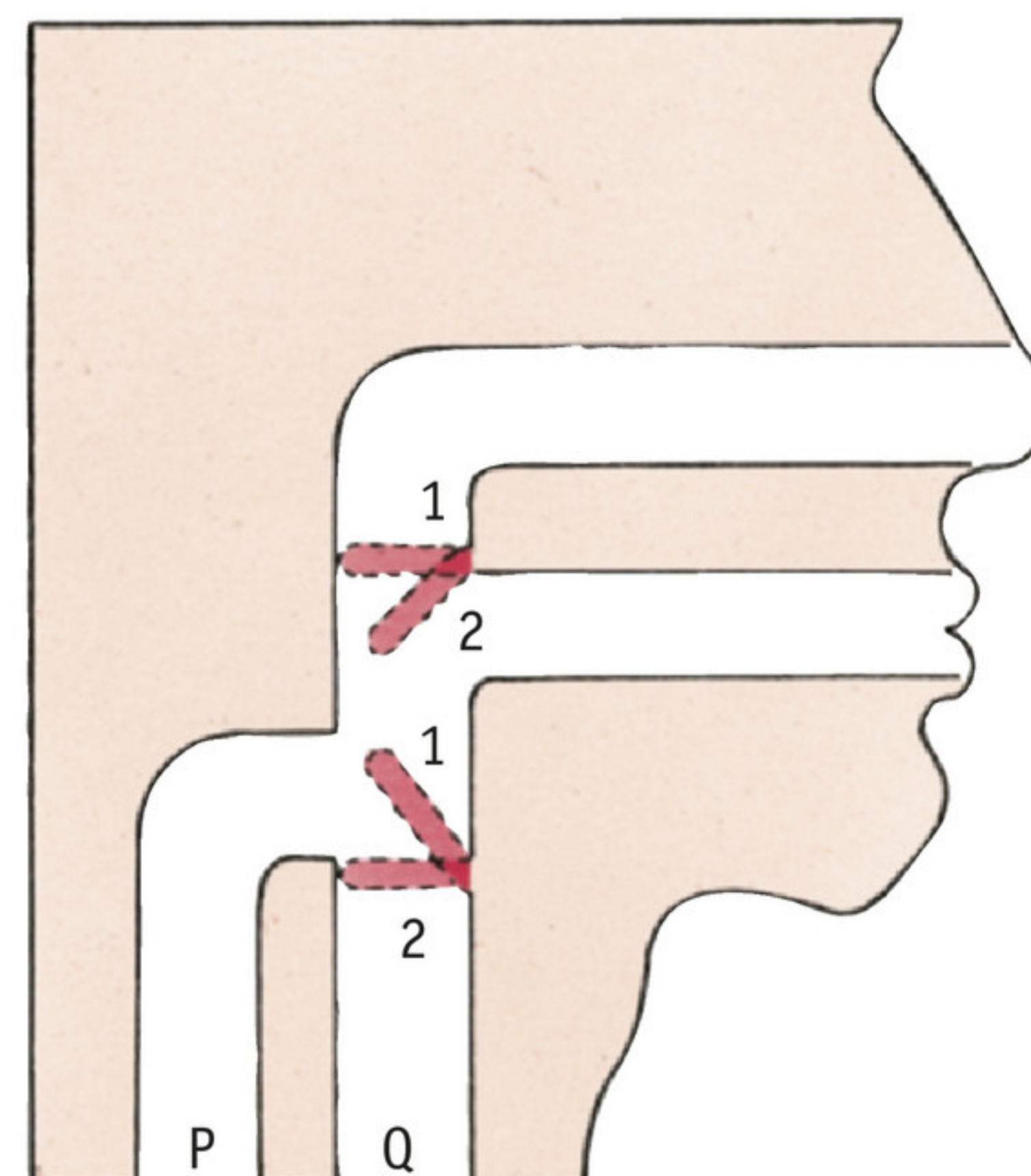
Figure 44 shows a schematic drawing of a cross-section of the pharynx. Two parts are labelled with letters. Two different positions for the uvula and the epiglottis are shown.

- 3 Which position is the uvula in for breathing? And in which position is the epiglottis?

	<i>The uvula</i>	<i>The epiglottis</i>
A	in position 1.	in position 1.
B	in position 1.	in position 2.
C	in position 2.	in position 1.
D	in position 2.	in position 2.

- 4 What happens when your food 'goes down the wrong way'? What causes this?
 - A Food gets into part P because the uvula is in the wrong position.
 - B Food gets into part P because the epiglottis is in the wrong position.
 - C Food gets into part Q because the uvula is in the wrong position.
 - D Food gets into part Q because the epiglottis is in the wrong position.

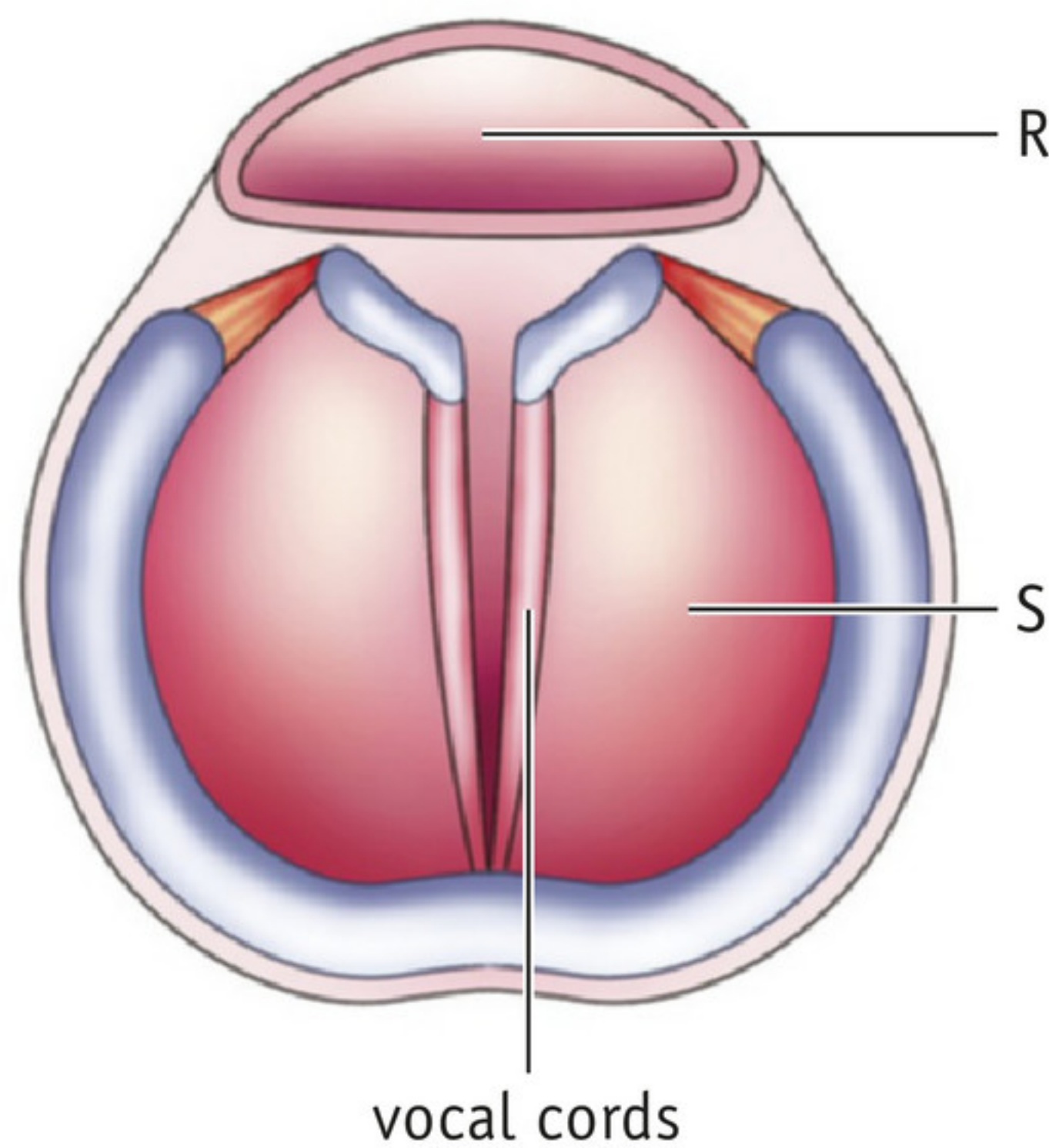
▼ Fig. 44



- 5 Figure 45 is a schematic diagram of a cross section of the human windpipe and oesophagus. Is the windpipe at R or S? And is R or S closer to the backbone?

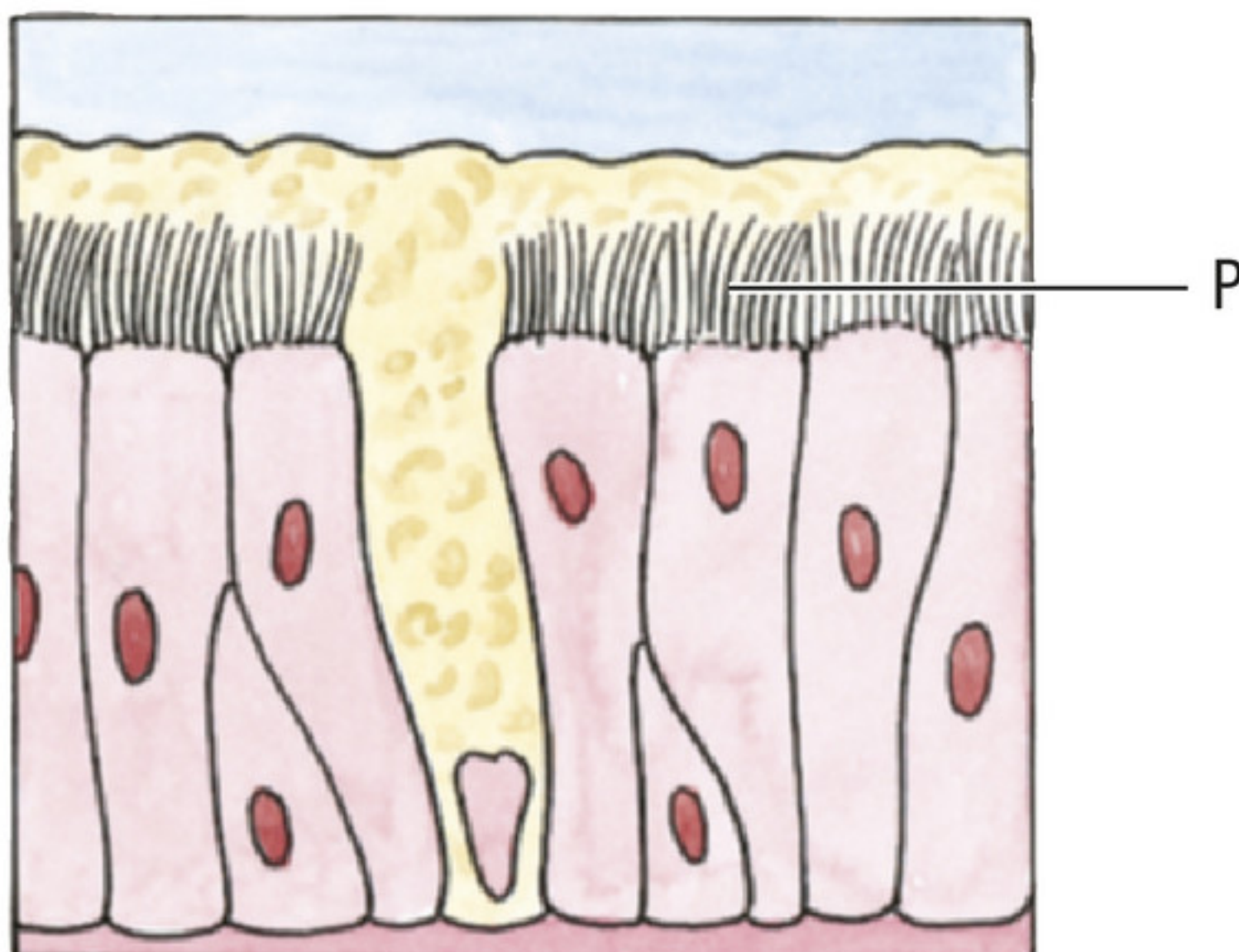
	<i>The windpipe is at letter</i>	<i>Nearest to the backbone is</i>
A	R.	R.
B	R.	S.
C	S.	R.
D	S.	S.

▼ Fig. 45



- 6 Figure 46 is a drawing of part of the wall of the human respiratory system, greatly enlarged. What is the function of part P?
- A To check the incoming air.
B To hold back inhaled dust particles.
C To produce mucus.
D To move mucus towards the pharynx.

▼ Fig. 46

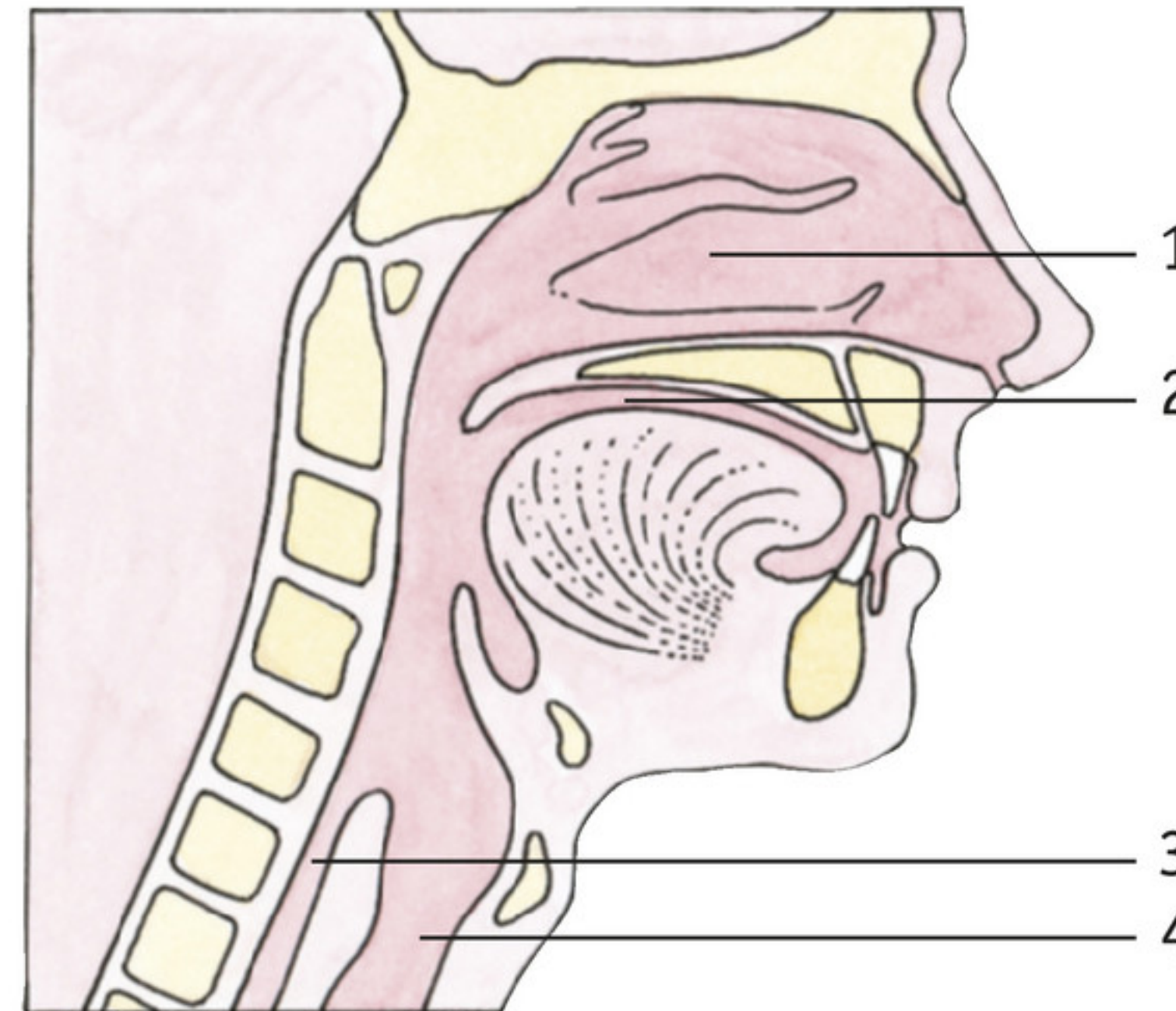


- 7 Figure 47 shows a drawing of a section through part of the head.

At which of the numbered locations in figure 47 can the tissue shown in figure 46 be found?

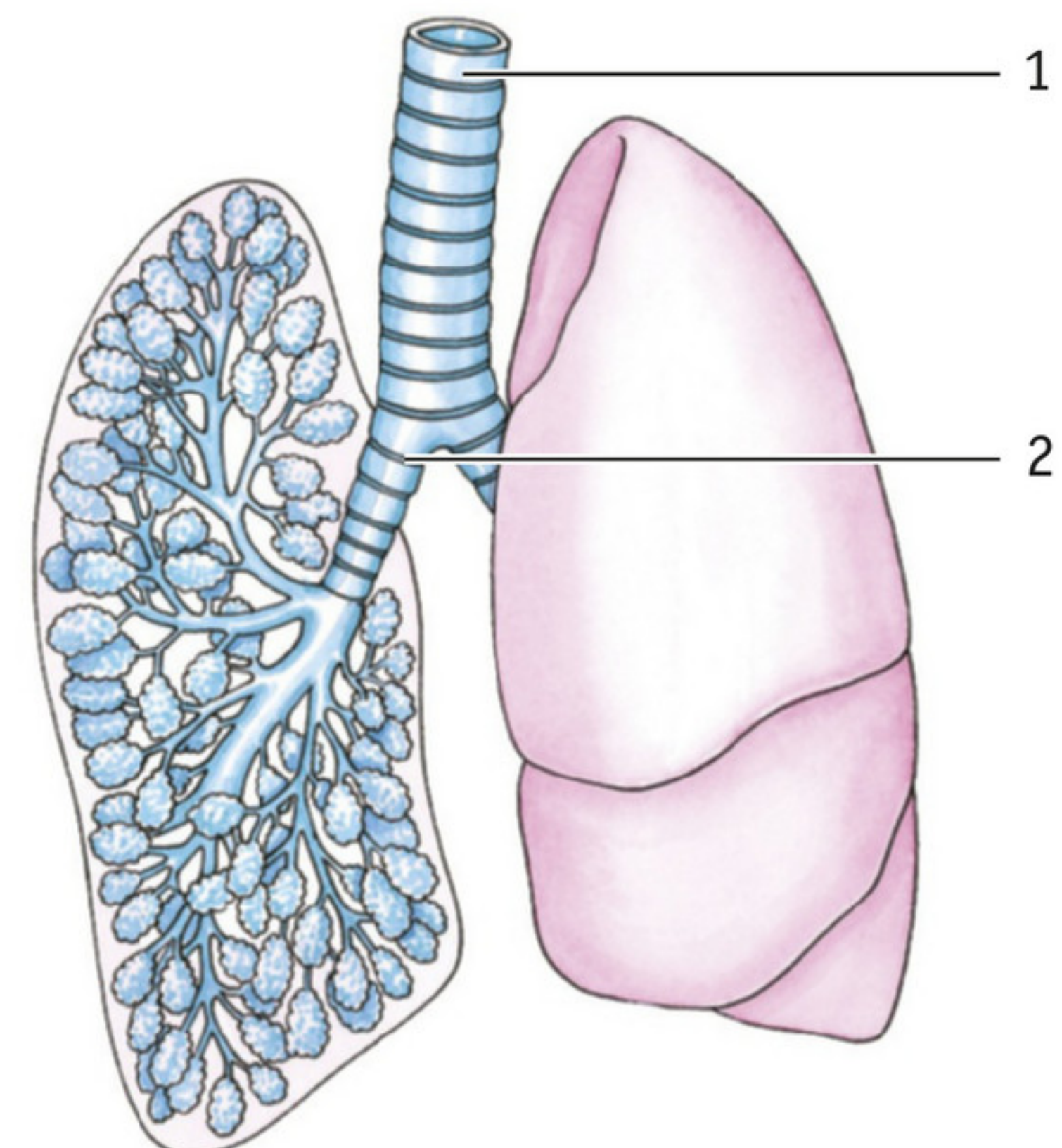
- A Only at number 4.
B At numbers 1 and 2.
C At numbers 1 and 4.
D At numbers 1, 3 and 4.

▼ Fig. 47



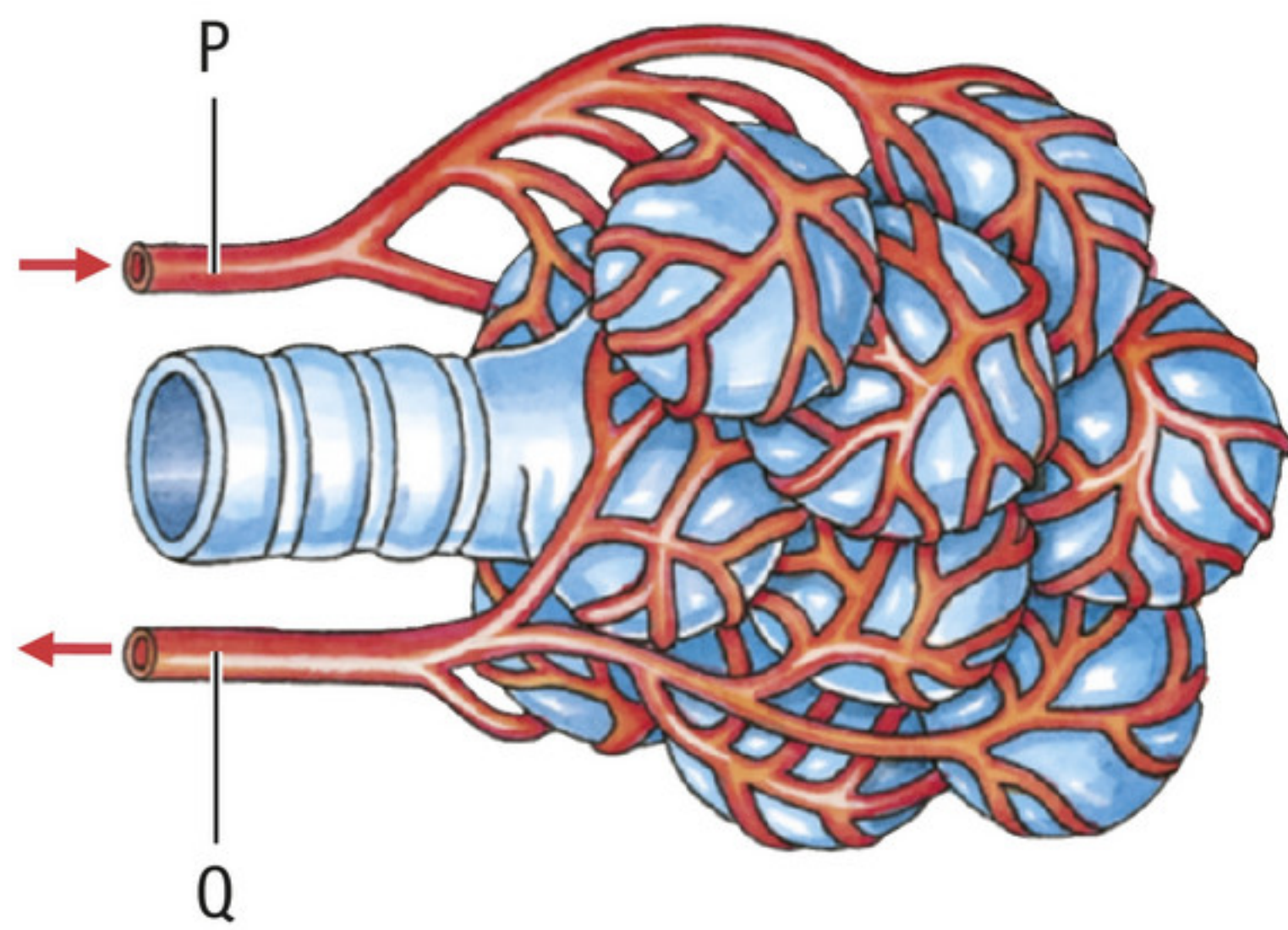
- 8 Figure 48 is a schematic diagram of part of the human respiratory system. Which of the numbered parts have walls that are reinforced with cartilage?
- A Only number 1.
B Only number 2.
C Number 1 and number 2.

▼ Fig. 48

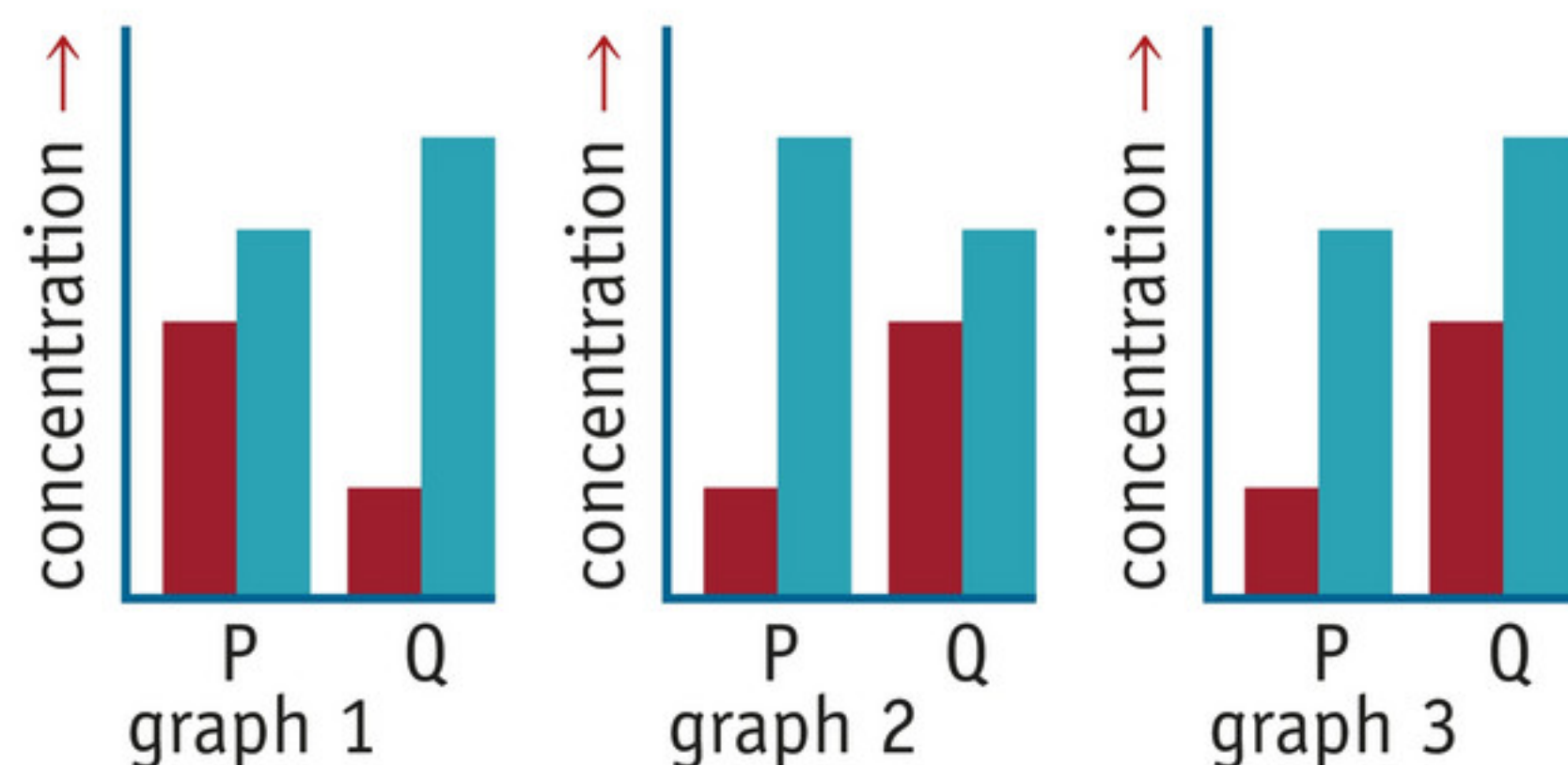


- 9 Figure 49 shows a small number of alveoli and lung capillaries in a human. The direction of blood flow is indicated by arrows. The oxygen and carbon dioxide levels of the blood are measured at points P and Q. Which of the graphs in figure 50 shows the results of these measurements correctly?
- A** Diagram 1.
B Diagram 2.
C Diagram 3.

▼ Fig. 49



▼ Fig. 50



Legend:

■ = oxygen
 ■ = carbon dioxide

- 10 When is the amount of oxygen in the alveoli the highest?
- A** Just after inhalation.
B Just before exhalation.
C During exhalation.

OBJECTIVE 6

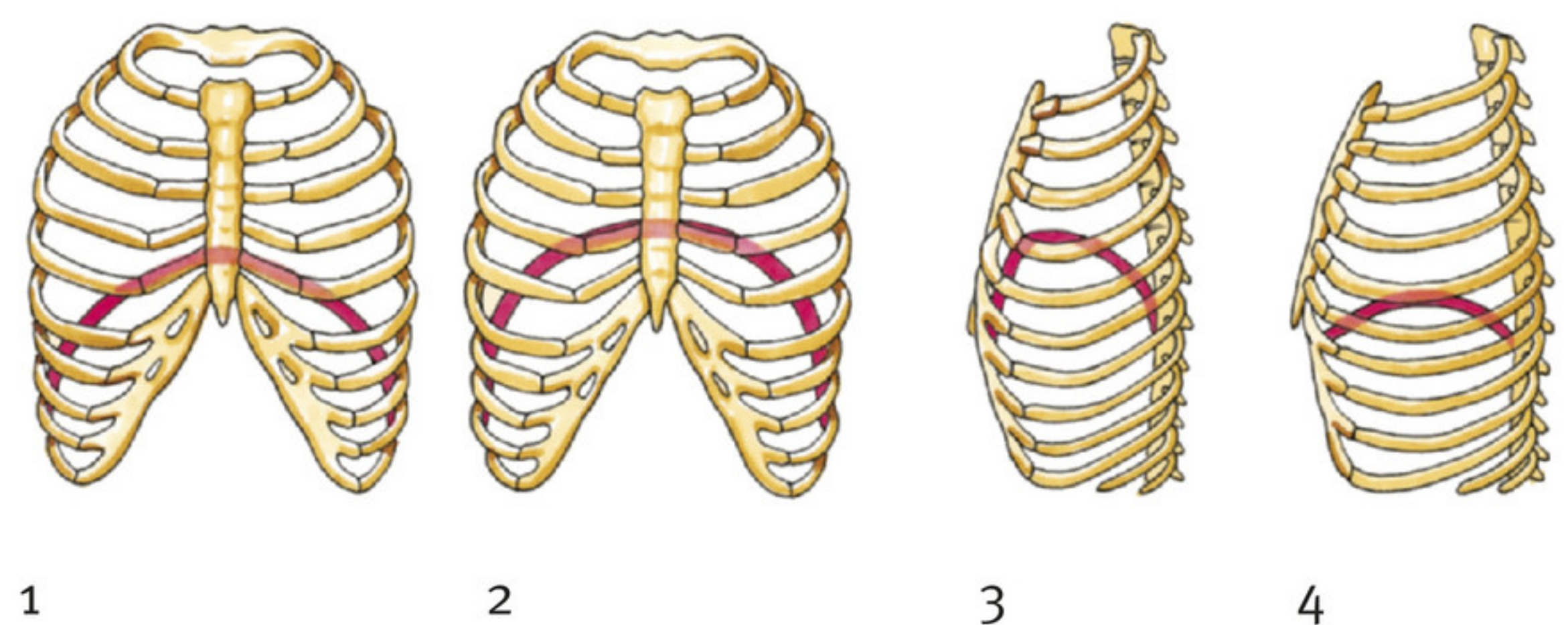
Answer the following multiple choice questions.

- 1 In which direction do the ribs and breastbone move when you inhale normally? And in which direction does the diaphragm move when you inhale normally?

<i>Ribs and breastbone</i>	<i>Diaphragm</i>
A up	up
B up	down
C down	up
D down	down

- 2 During which breathing movement does the abdomen move forwards?
- A** On inhaling in thoracic breathing.
B On inhaling in diaphragmatic breathing.
C On exhaling in thoracic breathing.
D On exhaling in diaphragmatic breathing.
- 3 On inhaling in thoracic breathing, the following take place:
- 1 The lungs become bigger.
 - 2 The air flows in.
 - 3 The ribs and breastbone move upwards.
 - 4 The chest cavity becomes bigger.
- What is the correct order in which these events take place?
- A** 2 – 1 – 4 – 3.
B 4 – 3 – 2 – 1.
C 3 – 4 – 1 – 2.
D 1 – 2 – 3 – 4.
- 4 A person's diaphragm moves upwards. Will this make the chest cavity larger or smaller? Does this result in inhalation or exhalation?
- A** The chest cavity becomes larger, causing inhalation.
B The chest cavity becomes larger, causing exhalation.
C The chest cavity becomes smaller, causing inhalation.
D The chest cavity becomes smaller, causing exhalation.
- 5 Figure 51 shows four schematic drawings of the ribcage. The red line shows the position of the diaphragm. Which drawings show the position after exhalation?
- A** Figures 1 and 3.
B Figures 1 and 4.
C Figures 2 and 3.
D Figures 2 and 4.

▼ Fig. 51



- 6 When you get hiccups, the muscles of the diaphragm tense up suddenly. Holding your breath or drinking a little water when you have hiccups will generally help get rid of them.

Is a hiccup a movement of the diaphragm upwards or downwards? Does it result in inhalation or exhalation?

The diaphragm goes Inhalation or exhalation

- | | |
|----------------|------------|
| A up. | inhalation |
| B up. | exhalation |
| C down. | inhalation |
| D down. | exhalation |

OBJECTIVE 7

Answer the following multiple choice questions.

- 1 Asthma patients sometimes suffer severe attacks. During an asthma attack, do the muscles in the walls of the smallest branches of the bronchi (the bronchioles) relax or contract? And is the lining on the inside of the airways very thin or is it thicker during an asthma attack?

The muscles The lining is

- | | |
|--------------------|------------|
| A contract. | very thin. |
| B contract. | thicker. |
| C relax. | very thin. |
| D relax. | thicker. |

- 2 Two pupils make statements about how an asthma attack occurs.
Luke says that dust in the air can be a trigger for an asthma attack.
Steven says that stress can be a trigger for an asthma attack.
Which of them is right?

- A** Neither of them is right.
B Only Luke is right.
C Only Steven is right.
D Both of them are right.

- 3 Can asthma be caused by smoking? What about COPD?

- A** Neither of them can be caused by smoking.
B Only asthma can be caused by smoking.
C Only COPD can be caused by smoking.
D Both asthma and COPD can be caused by smoking.

- 4 What are hay fever sufferers allergic to in particular?

- A** Flakes of skin from animals.
B Household dust.
C Cigarette smoke.
D Pollen grains.

- 5 Three symptoms that can appear in people who have an allergy are a burning sensation, a skin rash and itchiness.

Which of these symptoms can occur as the result of an allergic reaction?

- A** A burning sensation and a skin rash.
B A burning sensation and itchiness.
C A skin rash and itchiness.
D All three of the symptoms.

OBJECTIVE 8

Say whether each of the following statements is true or false.

- 1 The components of cigarette smoke include various gases.
- 2 Cigarette smoke only contains one specific carcinogen.
- 3 Nicotine damages the cilia in the respiratory tract.
- 4 Carbon monoxide is bad for your physical fitness.
- 5 The nicotine in cigarette smoke causes smoker's cough.
- 6 Smoking creates a need for nicotine.
- 7 In passive smoking, you breathe in the same substances as in active smoking.
- 8 A shopkeeper is allowed to sell cigarettes to a boy aged 17.
- 9 Smoking is permitted in a department of a company where all the employees smoke.
- 10 Smokers are physically dependent on nicotine, which makes breaking the habit difficult.

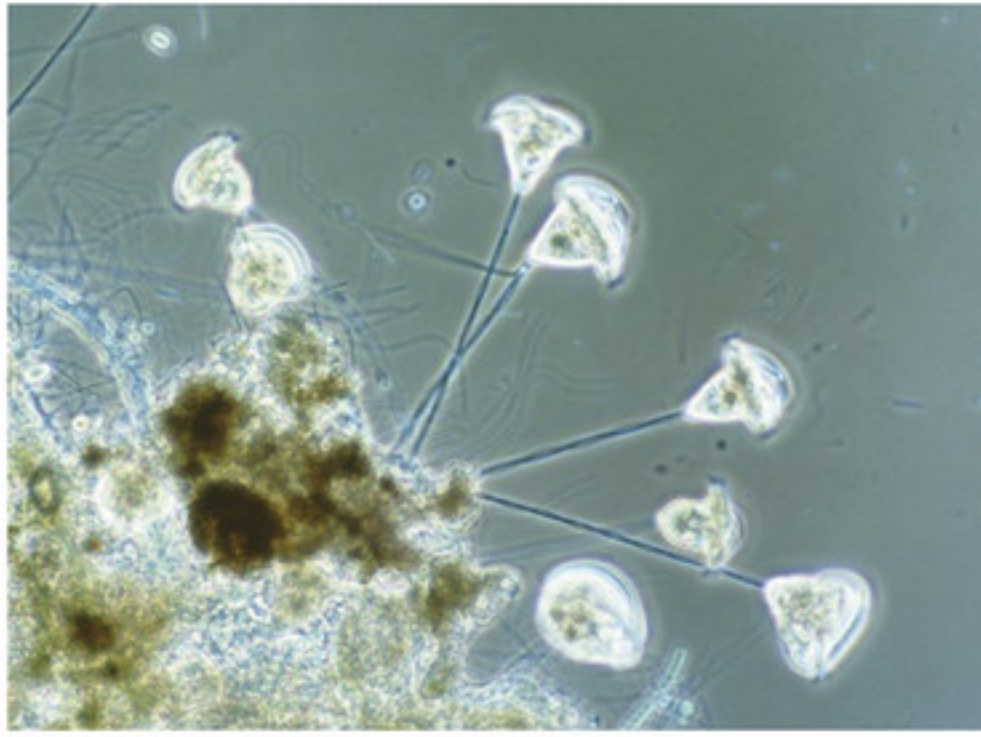
EXTRA OBJECTIVE 9

Answer the following questions.

- 1 The creatures living in the water of a ditch include backswimmers, vorticellae and paramecia (see figure 52).

In which of these animals does gas exchange take place through the cell membrane?

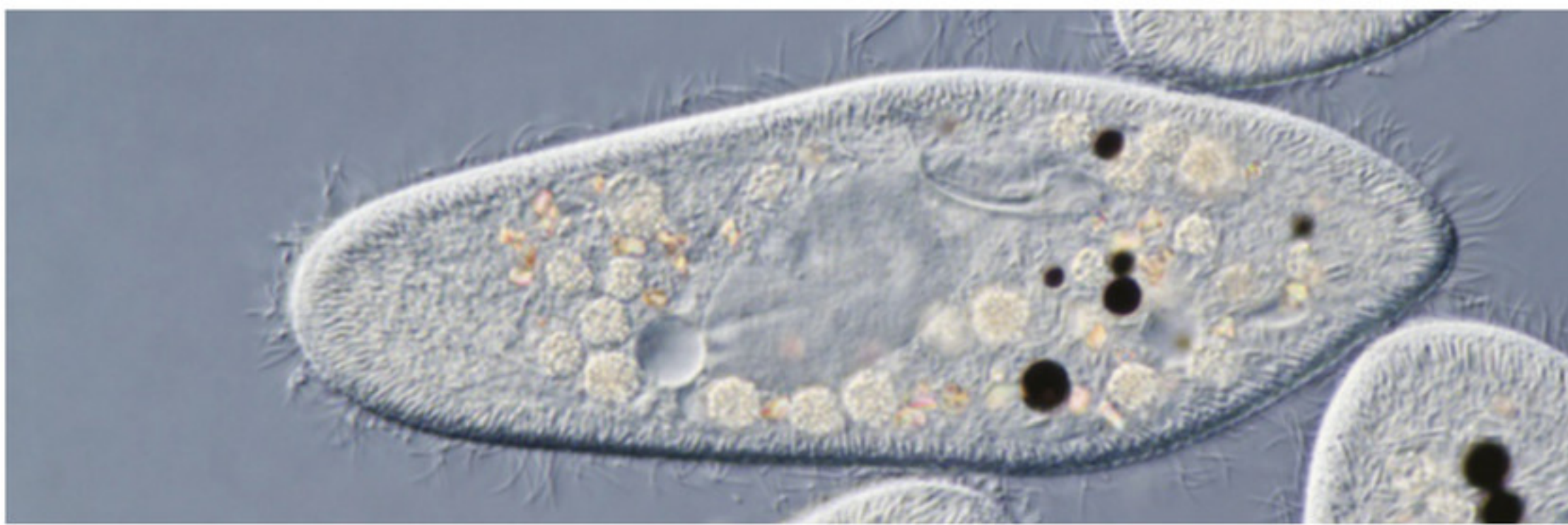
▼ Fig. 52



1 vorticella (100× magnification)



2 water boatman (backswimmer)

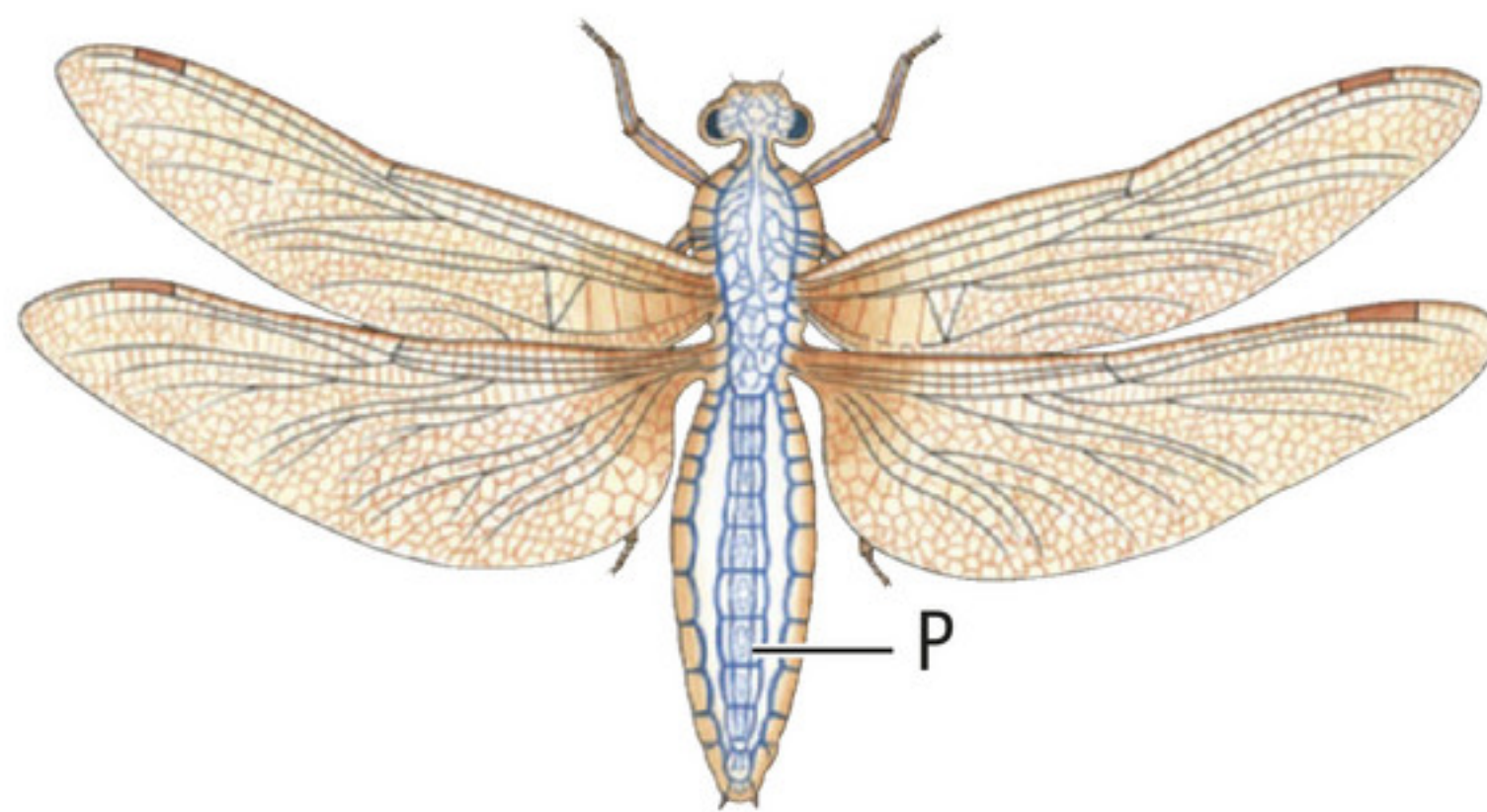


3 paramecia (250× magnification)

Figure 53 is a drawing of an insect. Parts of the respiratory system are marked with a letter P. Questions 2 and 3 are about this figure.

- 2 What do we call the parts indicated by letter P?
3 Is air or blood present at the point labelled P? Explain your answer.

► Fig. 53



- 4 If a wasp is sitting quietly (see figure 54), you will still see it moving its abdomen. What is the function of this movement?

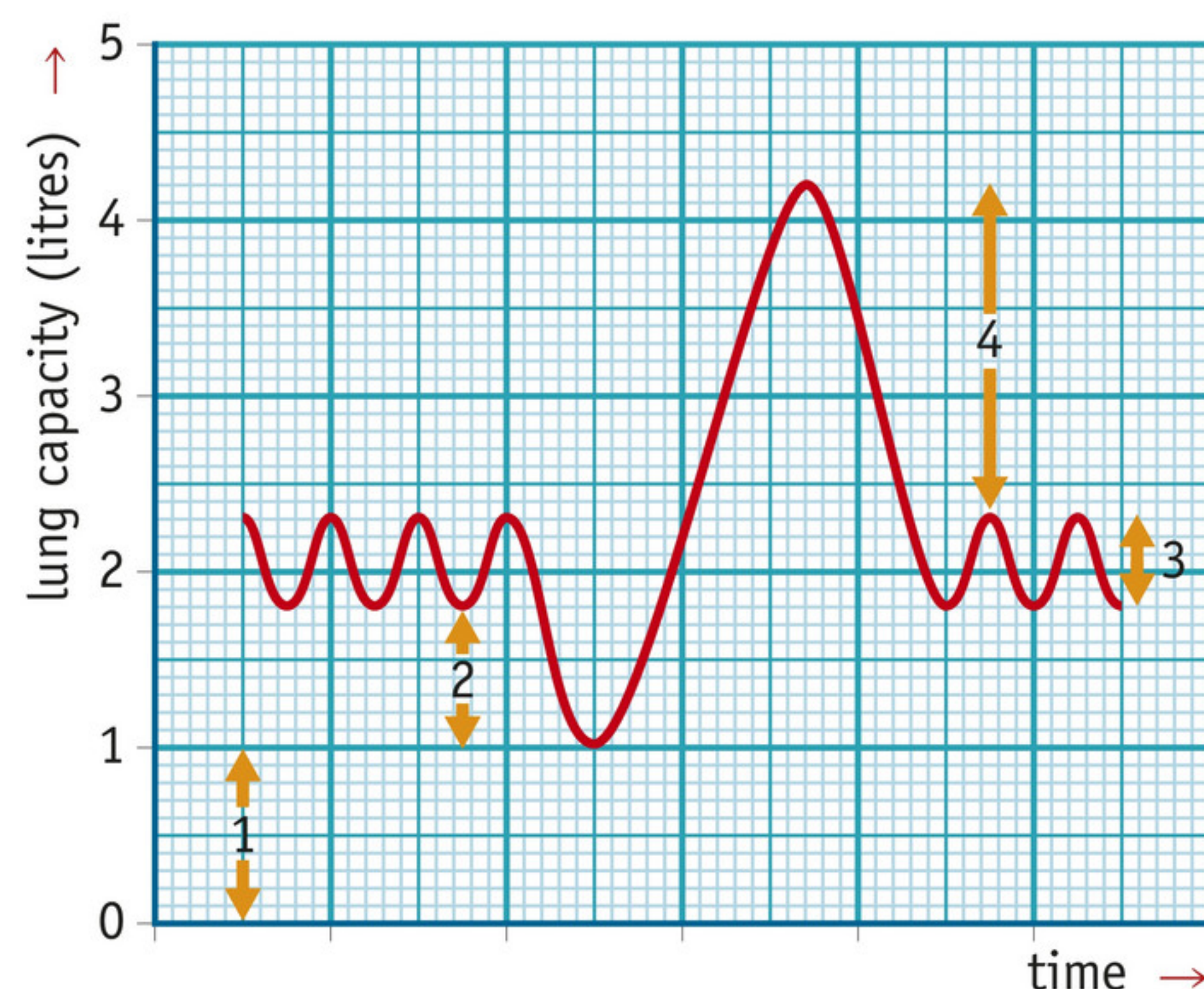
► Fig. 54

**EXTRA OBJECTIVE 10**

The graph in figure 55 shows the average lung volume for a specific person for various depths of breathing. Answer the following multiple choice questions using the figure.

- 1 There are four numbered arrows in the diagram. Which arrow indicates the tidal volume?
A Arrow 1.
B Arrow 2.
C Arrow 3.
D Arrow 4.
- 2 How many exhalations are shown in the diagram?
A 1.
B 6.
C 7.
D 12.
- 3 What is this person's maximum lung volume?
A About 1 L.
B About 2.4 L.
C About 3.2 L.
D About 4.2 L.
- 4 What is the vital capacity of this person?
A About 1 L.
B About 2.4 L.
C About 3.2 L.
D About 4.2 L.

▼ Fig. 55

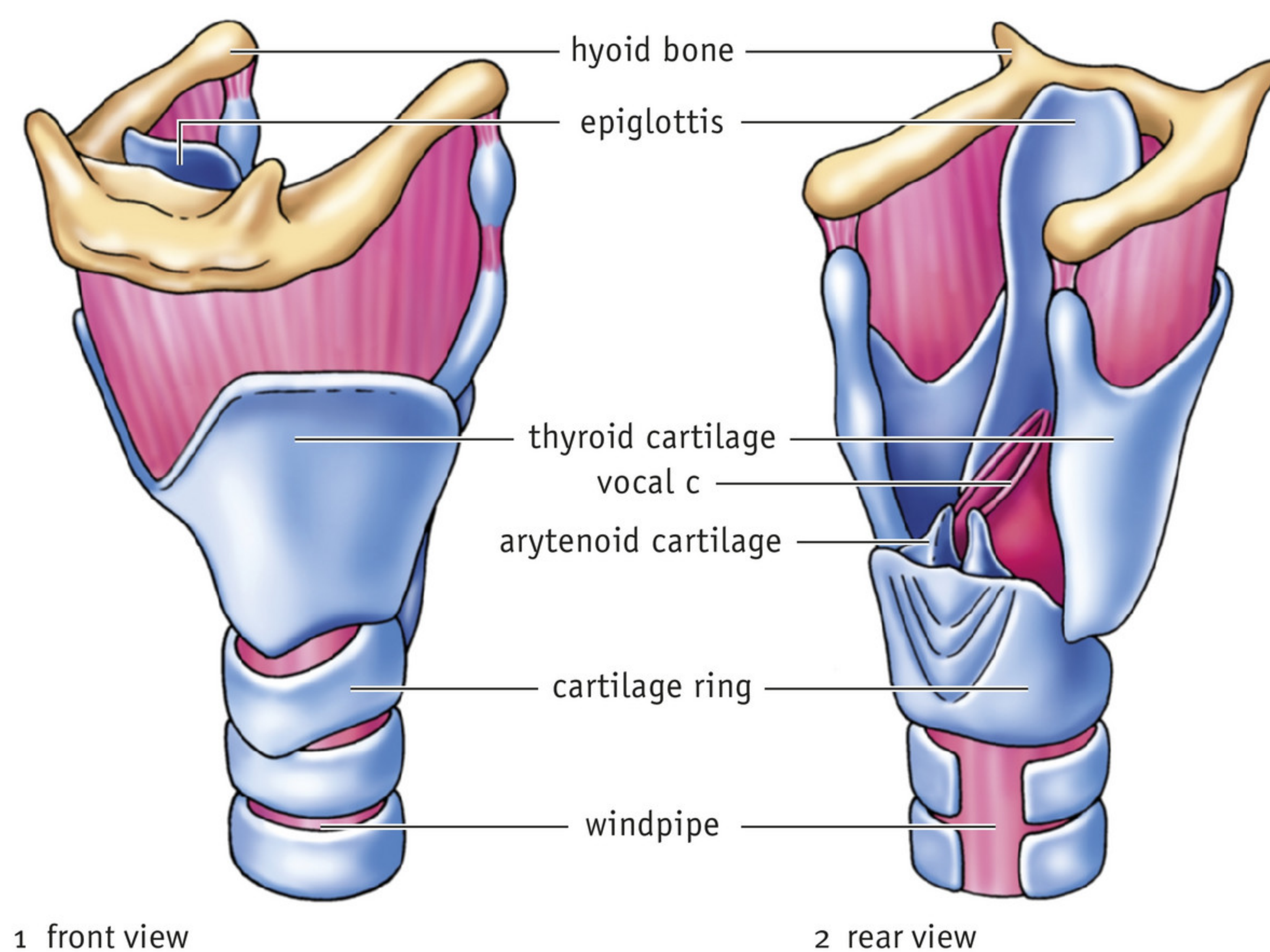


You can do the extension if you have time left over. You can choose between different topics. This unit's extension consists of three topics. You can do the exercises for them in your workbook. Your teacher will tell you how many topics you should choose.

1 The vocal cords

You have learned that the vocal cords are in the larynx (see figure 56). The **thyroid cartilage** is at the front of the larynx; you can feel it in your neck (the 'Adam's apple'). The **vocal cords** are behind the thyroid cartilage. These are two membranes that can be made to vibrate. The **hyoid bone** is at the top of the larynx. The muscles attached to it include the ones for moving the tongue.

▼ Fig. 56 Larynx (diagram).

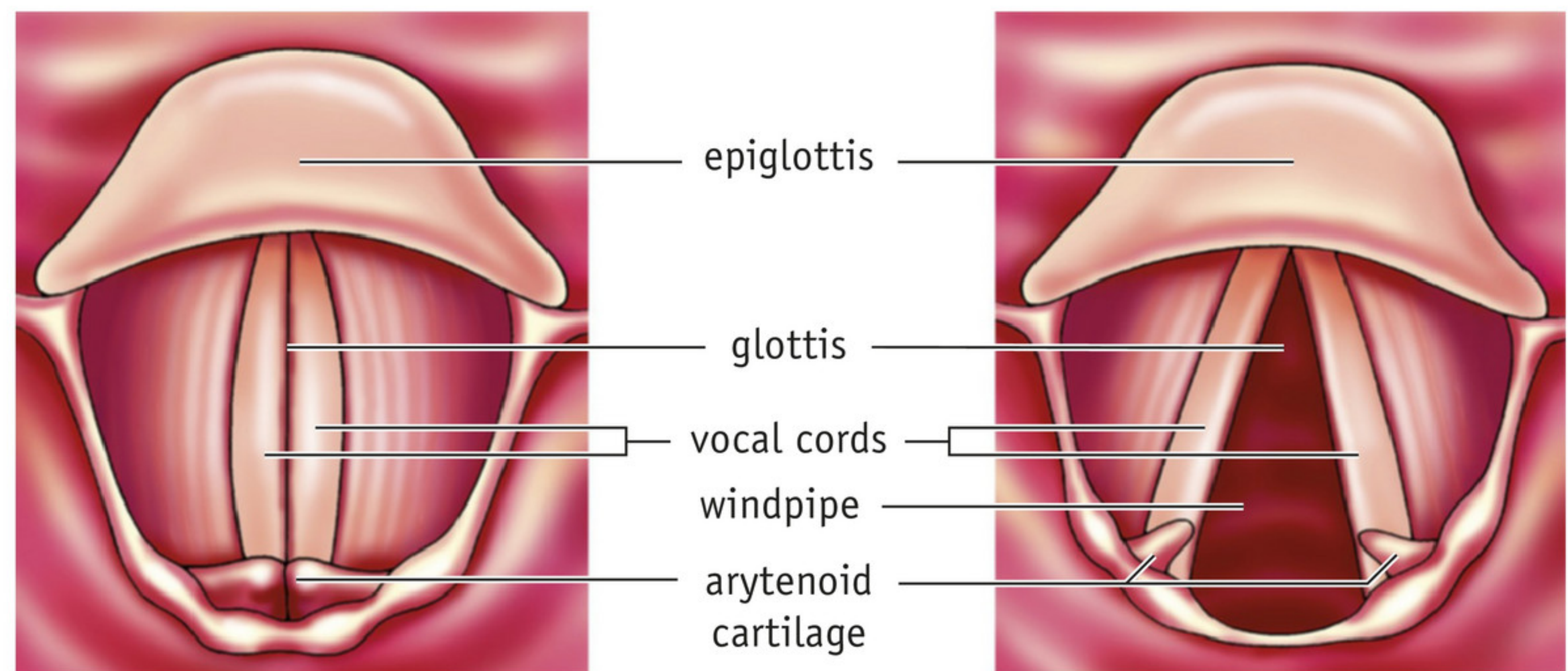


The larynx also contains the two small **arytenoid cartilages**. The **vocal cords** are located between the arytenoid cartilages and the thyroid cartilage (see figure 57). The arytenoid cartilages make it possible for the vocal cords to move towards each other or away from one another. This makes the **glottis** narrower or wider.

When you want to make a sound, you bring the vocal cords closer together. The air flowing past them as you breathe makes the vocal cords vibrate and sounds are produced. When the vocal cords are tightly stretched, they vibrate more rapidly and the sound is more high-pitched. To turn that noise into recognisable speech sounds, the position of the tongue, teeth and lips and the shape of the oral cavity are all important.

WB EXERCISES 1 AND 2, PAGE 34

▼ **Fig. 57** The vocal cords.



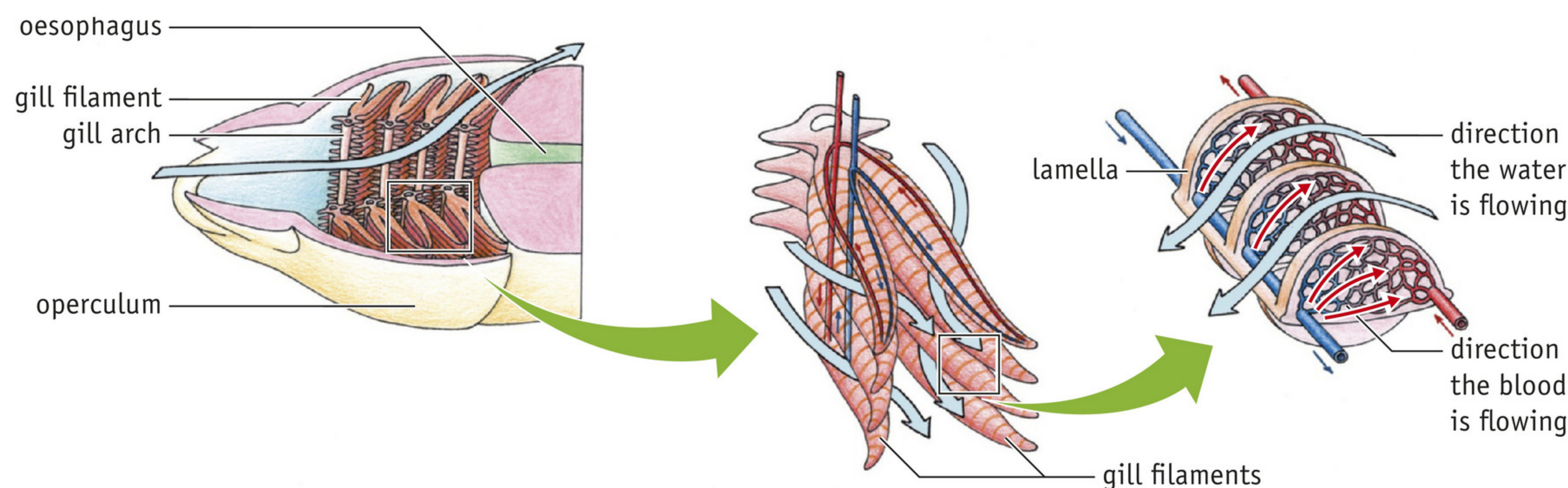
2 Respiratory organs in fish

Fish use gills to breathe. In this extension, you will learn about the structure of fishes' gills and how they work. You will have to answer questions about this, examine a fish's head and draw the gills.

A fish's gills are just behind the head in the **gill cavity**. The gill cavities are covered by **gill flaps** or **opercula**. A gill consists of a **gill arch** on which there are a large number of **gill filaments**. On the gill filaments are **lamellae**. Between the gill arches are the **gill slits** (see figure 58). The gill lamellae contain large numbers of thin blood vessels.

The walls of the lamellae are very thin. Taken all together, the lamellae have a very large surface area. These properties mean that oxygen can be extracted from the water quickly and absorbed into the fish's bloodstream. Carbon dioxide can be eliminated from the blood quickly into the water.

▼ **Fig. 58** The gills of a fish (schematic).

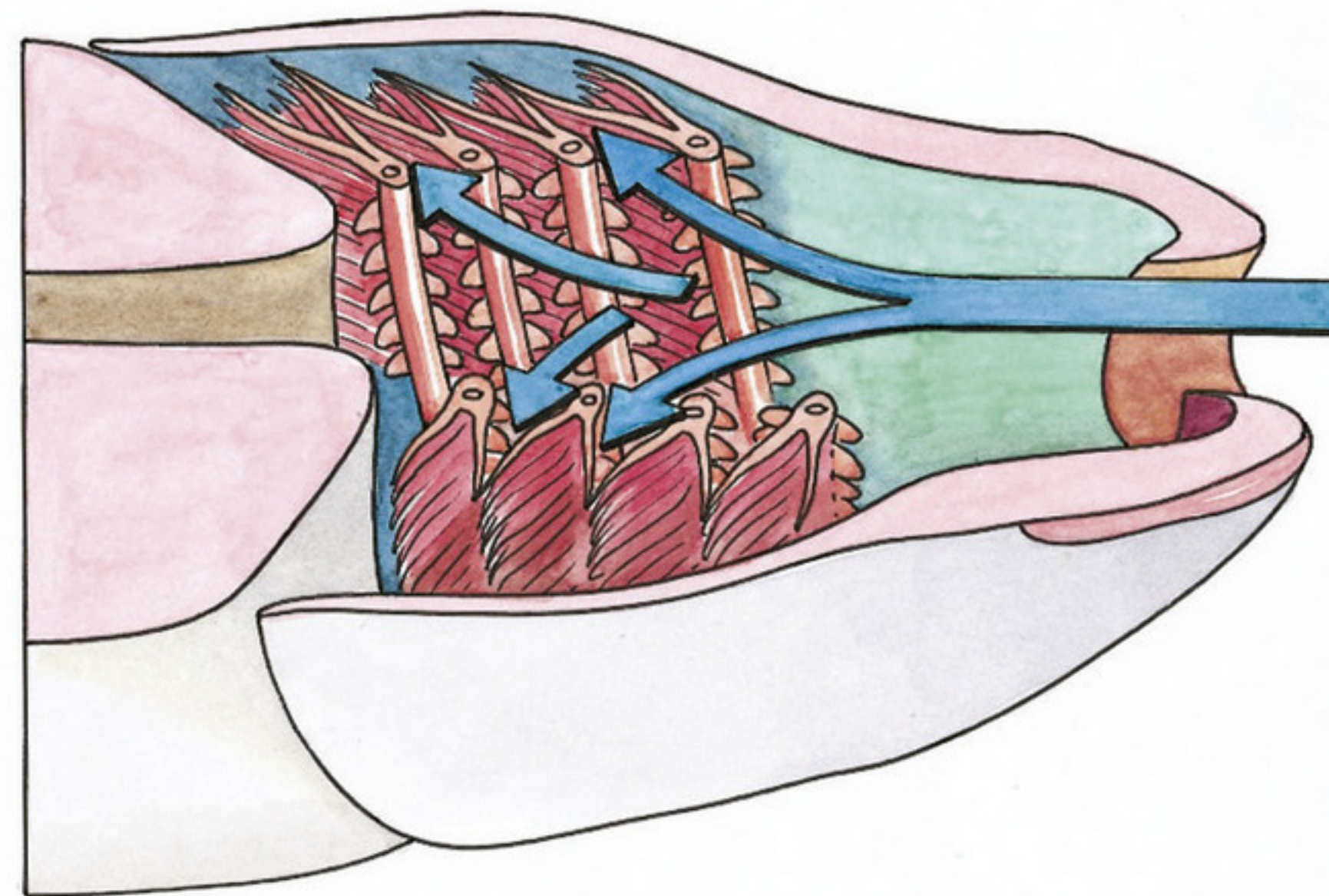


When we breathe, the air in our lungs is continuously refreshed. In fish, the water in the gill cavities is continuously refreshed as well. You can see that clearly in a fish in an aquarium as it opens and closes its mouth. You will also be able to see the gill flaps opening and closing.

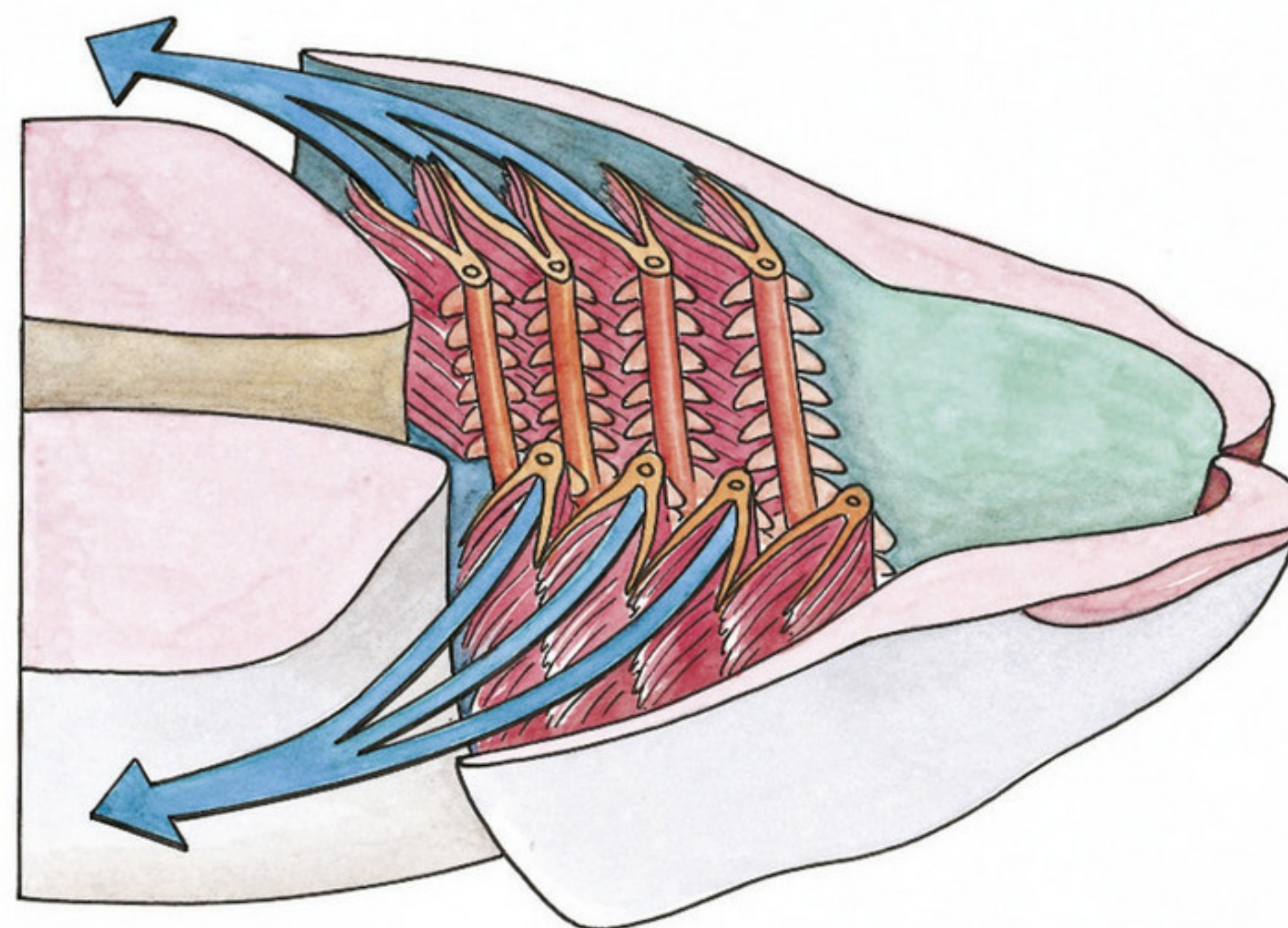
When a fish opens its mouth, fresh water flows into the oral cavity (see figure 59.1). The fish then closes its mouth and the floor of the mouth moves upwards. The water is then pressed from the mouth into the gill cavities. It flows between the gill filaments and gas exchange can take place. The water then leaves the fish when the gill flaps (opercula) open (see figure 59.2). The gill flaps then close and the mouth can open again. The next mouthful of water can now flow into the oral cavity.

WB EXERCISES 1 AND 2, PAGE 35

► **Fig. 59** Water flowing in and out.



- 1 mouth is open and the opercula are closed: water flows into the mouth cavity



- 2 mouth is closed and the opercula are open: water flows out over the gills

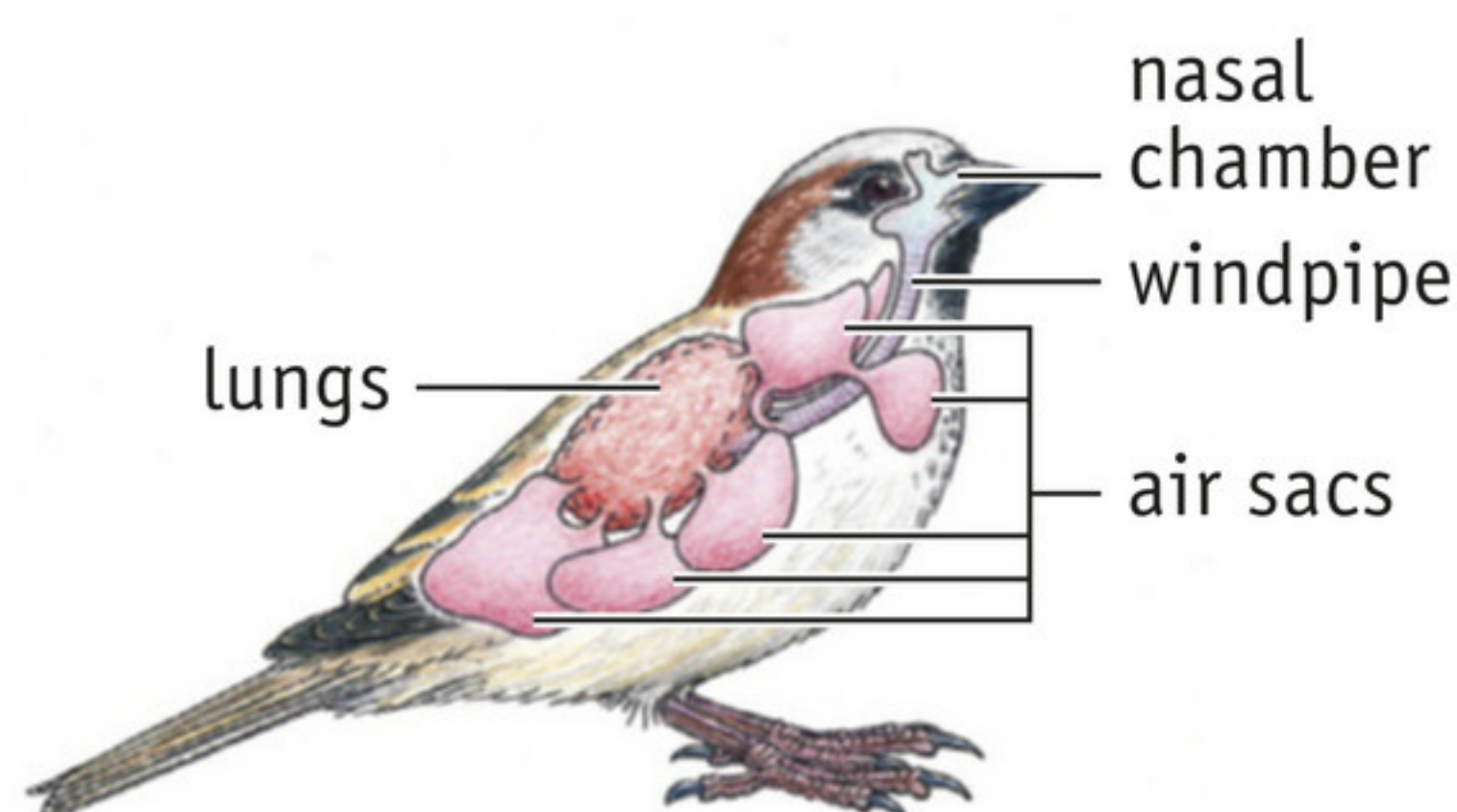
3 Breathing in birds

▼ **Fig. 60** The nostrils of a bird.



nostril

▼ **Fig. 61** The respiratory system of a bird.



In the basics you learned about the structure of human lungs. The lungs of other mammals have much the same structure. The thoracic cavity is made larger so that air flows into the lungs, and is then made smaller again to expel the air. Birds' lungs work differently. In this extension, you will learn about the structure of birds' lungs and how they work.

THE STRUCTURE OF A BIRD'S LUNGS

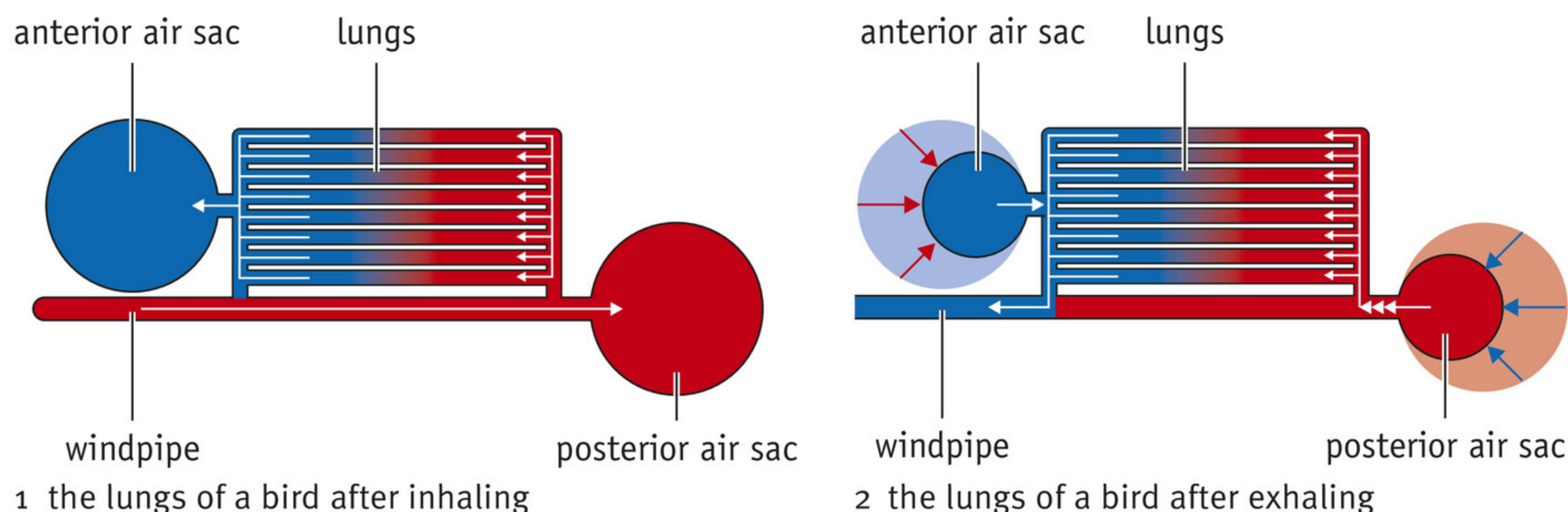
Birds have two nostrils at the top of the beak (see figure 60). There is a sort of nasal cavity behind these nostrils. In birds, it is known as the nasal chamber. The nasal chamber is where the air is warmed and moistened. This is also where their sense of smell is located. The nasal chamber is connected to the pharynx. The windpipe goes from the pharynx to the lungs. The lungs are smaller than in mammals and do not have alveoli. The lungs consist of lots of tiny tubes. Around the tubes are very small blood vessels. There are air sacs fixed in place around the lungs (see figure 61).

HOW BIRDS' LUNGS WORK

The respiratory system of birds is different to that of mammals. The bird's lungs do not change in volume. The air sacs around the lungs do, though. There are a number of air sacs at the front of the lungs (the anterior air sacs), and more of them at the back (the posterior air sacs). During inhalation, the air sacs get larger. Fresh air flows in through the windpipe into the posterior air sacs, while air flows through the lungs into the anterior air sacs (see figure 62.1). During exhalation, air flows out of the anterior air sacs and out through the windpipe, while air then flows from the posterior air sacs into the lungs (see figure 62.2). Because the air sacs act as a kind of bellows, air with plenty of oxygen is always flowing past the blood vessels in the lungs. This means that the exchange of oxygen and carbon dioxide can take place more quickly than in mammals.

WB EXERCISES 1 AND 2, PAGE 38

▼ **Fig. 62** How birds' lungs work (schematic).



2

Nutrition and digestion



BASICS

- 1 Food and nutrients
- 2 Testing for starch and glucose
- 3 Healthy food
- 4 How much is healthy?
- 5 Thinking about food
- 6 The digestive system
- 7 The teeth
- 8 The digestive organs

48
53
54
56
62
66
69
75

EXTRA

- 9 Nutrition and digestion in mammals
- 10 How do you stop food from spoiling?

79
81

SUMMARY AND DIAGNOSTIC TEST

- Summary
Diagnostic test

84
89

EXTENSION

- 1 Product information
- 2 Puzzle
- 3 Which parts of an animal do you eat?

97
98
98



This unit is called 'Nutrition and digestion'. Your food contains all kinds of substances. In this unit, you will learn how to make sure that your food contains all the substances your body needs and how to eat healthily.

The Earth can provide enough food. Even so, some people go hungry. You will learn how we can do something about this, for example by eating less meat.

Not all nutrients can simply be absorbed into the body. Most of the food has to be broken down first in the digestive system. You will learn what digestion is and which organs have a function in the digestion process.

When you read the basics, you will come across the exercises as you go. You should do the exercises in your workbook.

1 Food and nutrients

Foodstuffs are any product that you can eat or drink. Foodstuffs can be vegetable or animal in origin (see figure 1). In part 1, you learned that roots, stems, leaves, fruits and seeds can be eaten as food by humans. The plants that these parts come from have generally been specially grown for the purpose.

Animal foodstuffs come from animals or animal products. When you eat meat, this generally comes from animals that were bred for the purpose. Parts of these animals may also be processed, for example to make sausages. Eggs and milk are examples of animal products. All kinds of dairy products can be made from milk, such as butter, cheese and yoghurt.

WB EXERCISES 1 AND 2, PAGE 40

▼ Fig. 1 Foodstuffs.



1 plant-based foodstuffs



2 animal-based foodstuffs

▼ Fig. 2



1 your body uses building blocks for making new cells when you are hurt



2 your body uses fuels to give it energy

NUTRIENTS

Foodstuffs contain all kinds of nutrients. **Nutrients** are the usable components in food. Many plant-based foodstuffs also contain dietary fibre. **Dietary fibre** is the collective name for the indigestible parts of plants. Nutrients can have a variety of different functions in your body (see figure 2). **Building blocks** are the types of nutrients that are needed for your body to grow and develop and for repairing wounds and other damage. Your body can use building blocks to help make new cells and tissues. **Fuels** are the types of nutrients that provide **energy**. In unit 1 (Breathing and respiration), you learned that respiration takes place in every cell in your body. This form of combustion needs fuels to supply energy. All the organs in your body need energy so that they can function. Energy is needed to keep your body temperature up and for growth, development and repairs to your body.

Reserves are nutrients that are not immediately needed as building blocks or fuel. They can be stored up in certain parts of your body until you need them. There are six groups of nutrients: proteins, carbohydrates, fats, water, minerals (salts) and vitamins. You need all six groups of nutrients if you want to stay healthy. A lack of certain minerals and vitamins can cause illness. This is why minerals and vitamins are also said to act as **protective substances**.

PROTEINS

Proteins are important building blocks for your body. A lot of proteins are used when cytoplasm is formed, for instance. Proteins that are not used as building blocks are used as fuel. There are no reserves of proteins. Figure 3 shows you foodstuffs that contain a lot of protein.

▼ Fig. 3 Foods that contain a lot of protein.



CARBOHYDRATES

Carbohydrates include glucose, sugars, starch and glycogen. Carbohydrates are used primarily as fuel, but can also act as building blocks or food reserves. When the glucose level in your blood is high, glucose is converted into glycogen and stored in the liver and in your muscles. When the glucose level drops, glycogen is converted into glucose that is then released into the bloodstream.

Figure 4 shows you foodstuffs that contain a lot of carbohydrates. Potatoes contain lots of starch, for instance, and jam contains a lot of sugar. Animal-based foodstuffs generally do not contain much in the way of carbohydrates.

▼ **Fig. 4** Foods that contain a lot of carbohydrates.



▼ **Fig. 5** Foods that contain a lot of fats.



FATS

Fats are used primarily as fuel, but can also act as building blocks or as reserves.

There is no need for your food to contain much fat. If you take in more fat than you need, it is stored as a food reserve, for example beneath your skin. The subcutaneous fat layer then becomes thicker.

Figure 5 shows you foodstuffs that contain a lot of fats.

WATER

All organisms consist mostly of **water**. Your body for example is approximately 60% water. Water is therefore an important building block for your body. Water plays a key role in transporting substances around your body. Most substances in your body can only be transported properly if they are dissolved in water. Blood consists largely of water. We cannot last long without water. All drinks, as well as fruit and some vegetables, are foodstuffs that contain a lot of water (see figure 6).

▼ **Fig. 6** Foods that contain a lot of water.



MINERALS (SALTS)

Minerals are often also referred to as **salts**. You need all kinds of minerals as building blocks. You need calcium for strong bones, for instance. You learned in part 1 that calcium phosphate provides the strength (rigidity) of bone tissue. Minerals can also have a protective effect.

Figure 7 shows you foodstuffs that contain a lot of minerals. You only need a small amount of the minerals each day. A normal, healthy diet contains enough minerals. In fact, we often use too much salt (see figure 8).

▼ **Fig. 7** Foods that contain a lot of minerals.



▼ **Fig. 8**

5000 deaths annually because of too much salt

Eating too much salt results in about five thousand people dying every year in the Netherlands. That was the conclusion reached by researchers at Wageningen University and the Dutch Consumers' Association. It is estimated that an average consumer eats about eight to ten grams of salt a day. That is significantly more than the six grams recommended as the norm by the Health Council. If the norm of six grams a day was observed, over 5000 fewer people would die from strokes and heart attacks. Even so, it is difficult to comply with the norm of six grams a day. This is because food manufacturers add a lot of salt to their products.



VITAMINS

Vitamins can be used as building blocks or may have a protective role. If you do not get enough vitamins, you will become ill. But consuming large quantities of vitamins can make you ill as well. A normal, healthy diet contains enough vitamins. Extra vitamins (such as vitamin pills) are therefore best only used when prescribed by a doctor.

Vitamins are identified by letters. Important vitamins are A, B, C, D and K. Vitamin A is for example needed for producing skin and for seeing well; vitamin D is needed to help the bones take up calcium phosphate. Figure 9 shows you foodstuffs that contain a lot of vitamins.

WB EXERCISES 3 TO 5, PAGE 41

▼ **Fig. 9** Foods that contain a lot of vitamins.



▼ **Fig. 10**

The 'hunger knock'

Athletes can get energy from both carbohydrates and fats. Carbohydrates provide energy much more quickly than fats. When making a big effort, such as climbing a mountain, road cyclists therefore depend on their carbohydrate reserves. The body stores carbohydrates as glycogen. The problem is that the body only has two relatively small reservoirs for storing glycogen: the liver and the muscles.

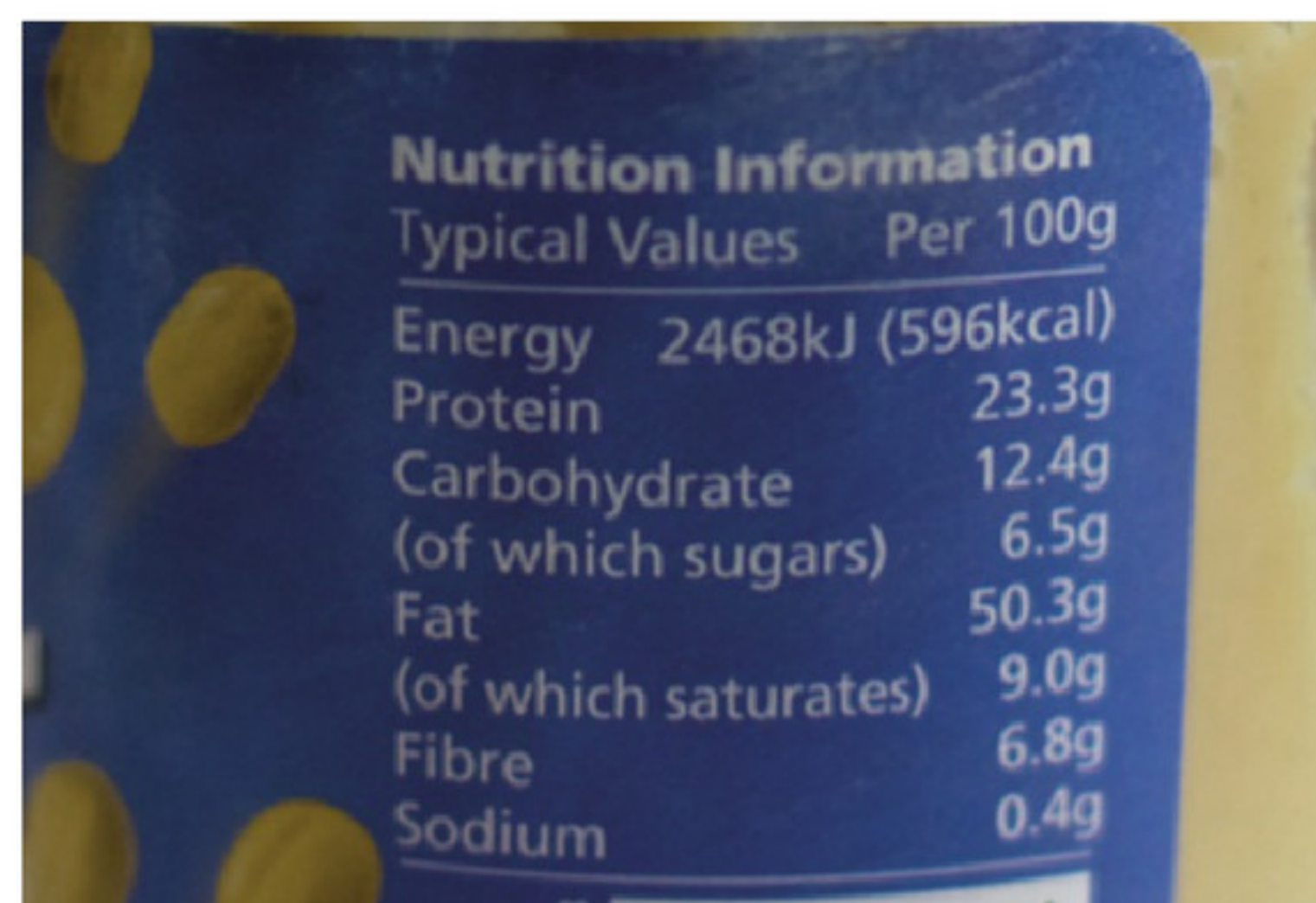
The store of glycogen in the liver and muscles is enough for no more than one or two hours of intense effort. Road cyclists therefore have to replenish those stocks during each stage. Only burning fat does not generate energy quickly enough for racing up a mountain. Once the glycogen stocks are used up, the cyclist gets what is called a 'hunger knock': the body switches to burning fat, the cyclist runs out of steam and can quickly lose several minutes.



Chris Froome, who went on to win the 2013 Tour de France, had a hunger knock on 18 July 2013 during the climb of the Alpe d'Huez.

2 Testing for starch and glucose

▼ Fig. 11



Nutrition Information	
Typical Values	Per 100g
Energy	2468kJ (596kcal)
Protein	23.3g
Carbohydrate	12.4g
(of which sugars)	6.5g
Fat	50.3g
(of which saturates)	9.0g
Fibre	6.8g
Sodium	0.4g

The nutritional content of most foodstuffs has already been tested. This information is listed on most packaging (see figure 11).

You can test some foodstuffs yourself to see what nutrients are in them. You are going to do that for starch and glucose.

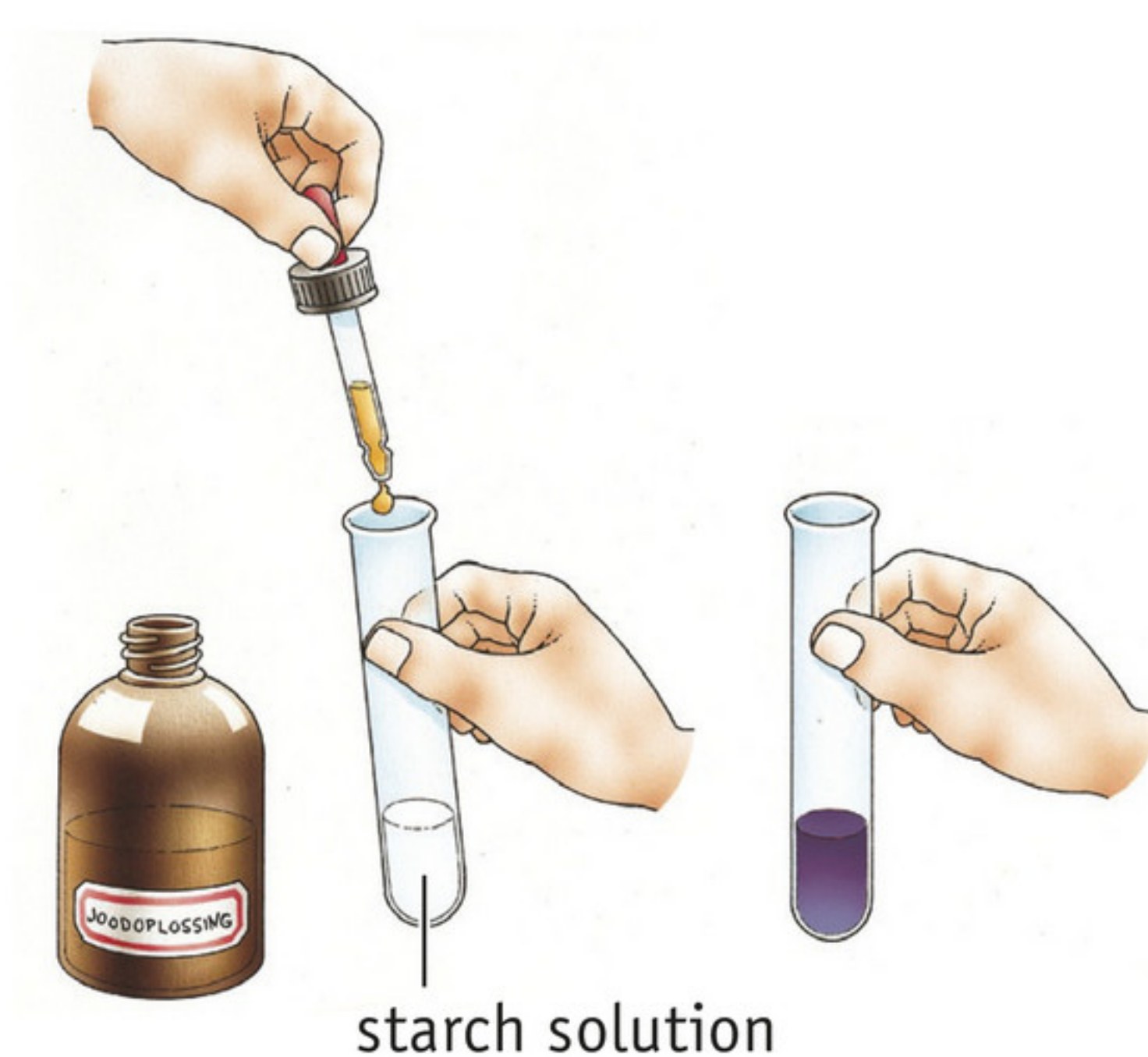
You can test for starch using iodine solution (see figure 12).

You learned in unit 1 (Breathing and respiration) that the substance used for the test is called an indicator. Iodine solution is an indicator for starch.

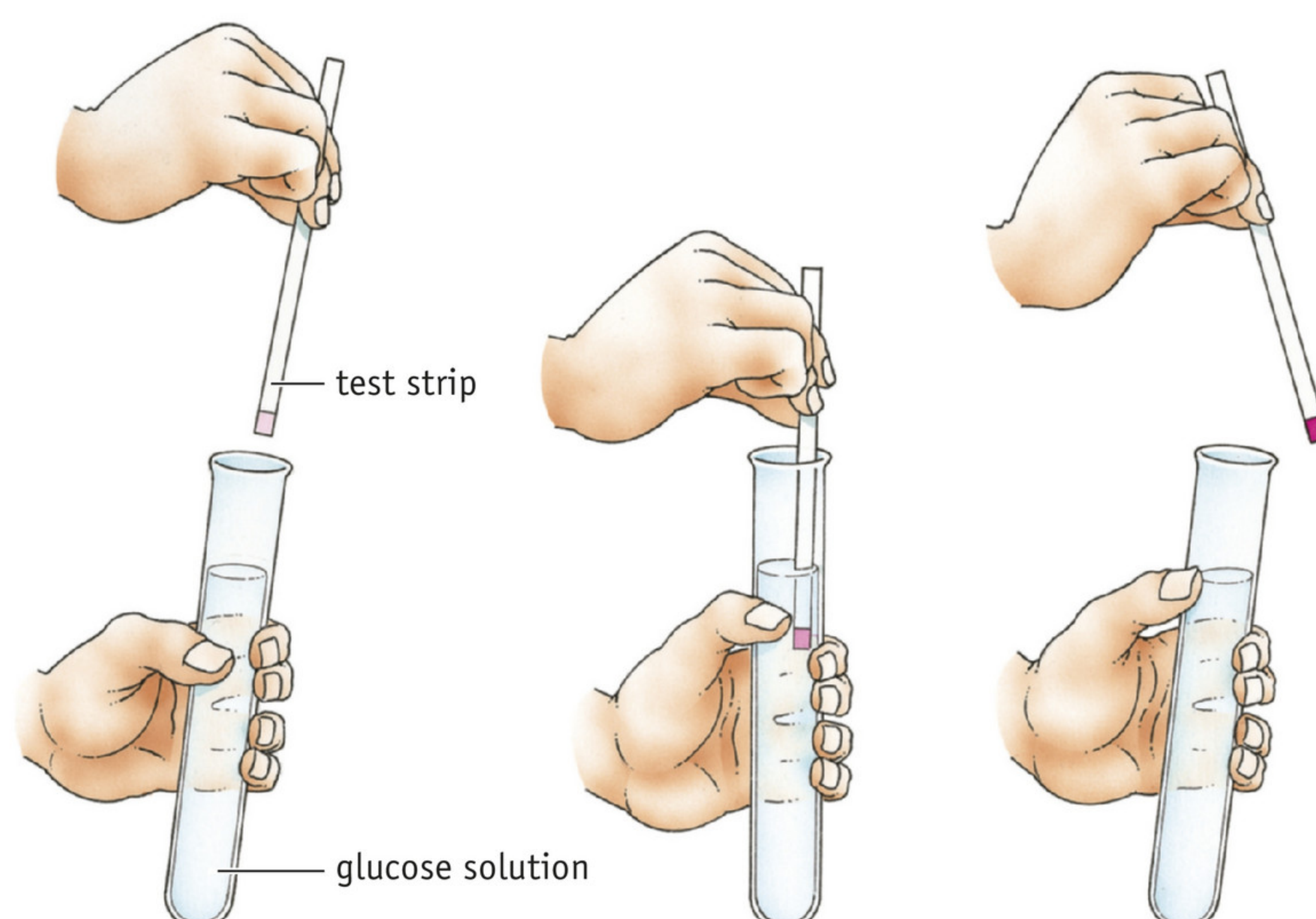
We will be using test strips as the indicator for glucose (see figure 13). There is a substance on the test strip that changes colour. A doctor may use the same test strips for testing for glucose in urine.

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▼ Fig. 12 Demonstrating the presence of starch.



▼ Fig. 13 Demonstrating the presence of glucose.



3 Healthy food

Good nutrition is needed if you are to stay healthy. The basis of healthy nutrition is **variation**. All the products that you eat and drink can be part of a healthy diet, as long as you use them in the right proportions in the right quantities (see figure 14). It is also important that you consume food that is safe. Food may be contaminated with germs. **Food poisoning** is an infection caused by eating food that has been contaminated with chemicals, bacteria or other germs.

▼ Fig. 14

Fatty fish for rheumatism

People who eat fatty fish at least once a week have a 52% lower chance of getting rheumatoid arthritis. This was demonstrated by a Swedish study of more than 32,000 women. Rheumatoid arthritis is a chronic (permanent) condition involving inflammation of the joints. Fatty fish such as mackerel, salmon and herring contain relatively large amounts of omega-3 fatty acids,

which inhibit the inflammation. Too much fatty fish is not good for you, though. Because of environmental pollution, fatty fish in particular can contain harmful substances such as dioxins and heavy metals. The Netherlands Nutrition Centre therefore recommends eating a maximum of four portions (maximum 600 g) per week.

ADVICE FOR HEALTHY EATING

The Netherlands Nutrition Centre has drawn up a 'Wheel of Five' plus five recommendations for healthy eating (see figures 15 and 16). The Wheel of Five has five sections, one for each of the groups of foodstuffs that we need on a daily basis. If you eat food from each section every day, your body will get all the nutrients it needs. You should eat more food from the larger sections than from the small ones. The large sections contain foods derived from plants.

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▼ Fig. 15 The 'Wheel of Five'.

SECTION 1

Eat plenty of vegetables and fruit every day. These foodstuffs provide vitamin C and dietary fibre in particular.

SECTION 3

Drink milk every day and eat cheese (or other dairy products) every day, plus red meat, meat products, chicken, fish, eggs, tofu or other meat substitutes. Tofu is made from soybeans. They are often eaten instead of meat. Foodstuffs from section 3 provide above all (animal) protein, vitamins and minerals (including calcium and iron). It is best to eat the less fatty variants, such as semi-skimmed milk and low-fat yoghurt. Eat (oily) fish twice a week.

**SECTION 2**

Eat plenty of bread and potatoes (or rice, macaroni, spaghetti, pulses, couscous). These foodstuffs provide starch, plant proteins, vitamins, minerals and dietary fibre in particular. The darker-coloured versions are usually better, for instance brown bread, brown rice and whole-grain macaroni. These contain a lot of dietary fibre.

SECTION 5

Drink enough liquid every day.

SECTION 4

Eat margarine, light margarine or oils on a daily basis. These foodstuffs provide fats and vitamins in particular. Do not use a lot of fat! It is better to use vegetable fats than animal fats.

► Fig. 16

ADVICE FOR HEALTHY EATING**1 Eat a varied diet**

- Eat something from each of the five sections of the Wheel of Five every day.

2 Do not eat too much and take plenty of exercise

- A good daily menu consists of three meals and not more than three to four snacks between meals.
- Do not consume too much fat, sugar or alcohol.

3 Eat less saturated fat

- Do not eat a lot of saturated fat. Animal fats in particular tend to be saturated.
- Choose light margarine from a tub, liquid fats and oils. These products contain a lot of unsaturated fats.

4 Eat plenty of vegetables, fruit and bread

- Vegetables, fruit and bread do not contain lots of high-energy substances but do have lots of nutrients. They make you feel full quickly.

5 Eat safely

- Good food hygiene will help you avoid food poisoning.

4 How much is healthy?

Your body uses your food as building materials, fuel, reserves and for protection. All these functions added together determine how much food you need.

ENERGY

A large proportion of your food is used as fuel. That part of your food provides the energy that your body needs. The unit of energy is the **joule** (symbol J). One kilojoule (kJ) is 1000 joules. An older unit that is still widely used is the **calorie** (cal). One kilocalorie (kcal) is 1000 calories.

You can convert between the units using the following formula:

$$1 \text{ kcal} = 4.2 \text{ kJ}$$

The amount of energy a person needs per day depends on a variety of factors, such as their **gender**, their **age**, their **body size** and the amount of **physical effort**. The **climate** and the **season** are important as well. When the weather is warm, you need less energy to keep your body temperature up.

Boys (men) generally need more energy than girls (women). While you are growing, your energy requirements are greater. A large body needs more energy than a small body.

Major physical efforts (such as playing sports) demand more energy than sleeping.

In adults, the energy requirement depends strongly on what work they do. Someone who does heavy physical work needs more energy than someone with an office job, for instance. Energy requirements are lower in older people too. Table 1 shows the average energy requirement for various phases of life and different lifestyles.

Figure 17 shows you roughly how much energy you need for various activities. Note that you also need energy even when you are resting.

▼ **Table 1** Average daily energy requirements (in kJ).

	kJ per day
Boys aged 14 to 18	
with a relatively inactive lifestyle	12,100
with an active lifestyle	13,800
Girls aged 14 to 18	
with a relatively inactive lifestyle	9200
with an active lifestyle	10,500
Men aged 31–50	
light physical work	10,500
heavy physical work	12,100
Women aged 31–50	
light physical work	8400
heavy physical work	9500

▼ **Fig. 17** Energy requirements for various activities.



sleeping:
4.2 kJ per minute



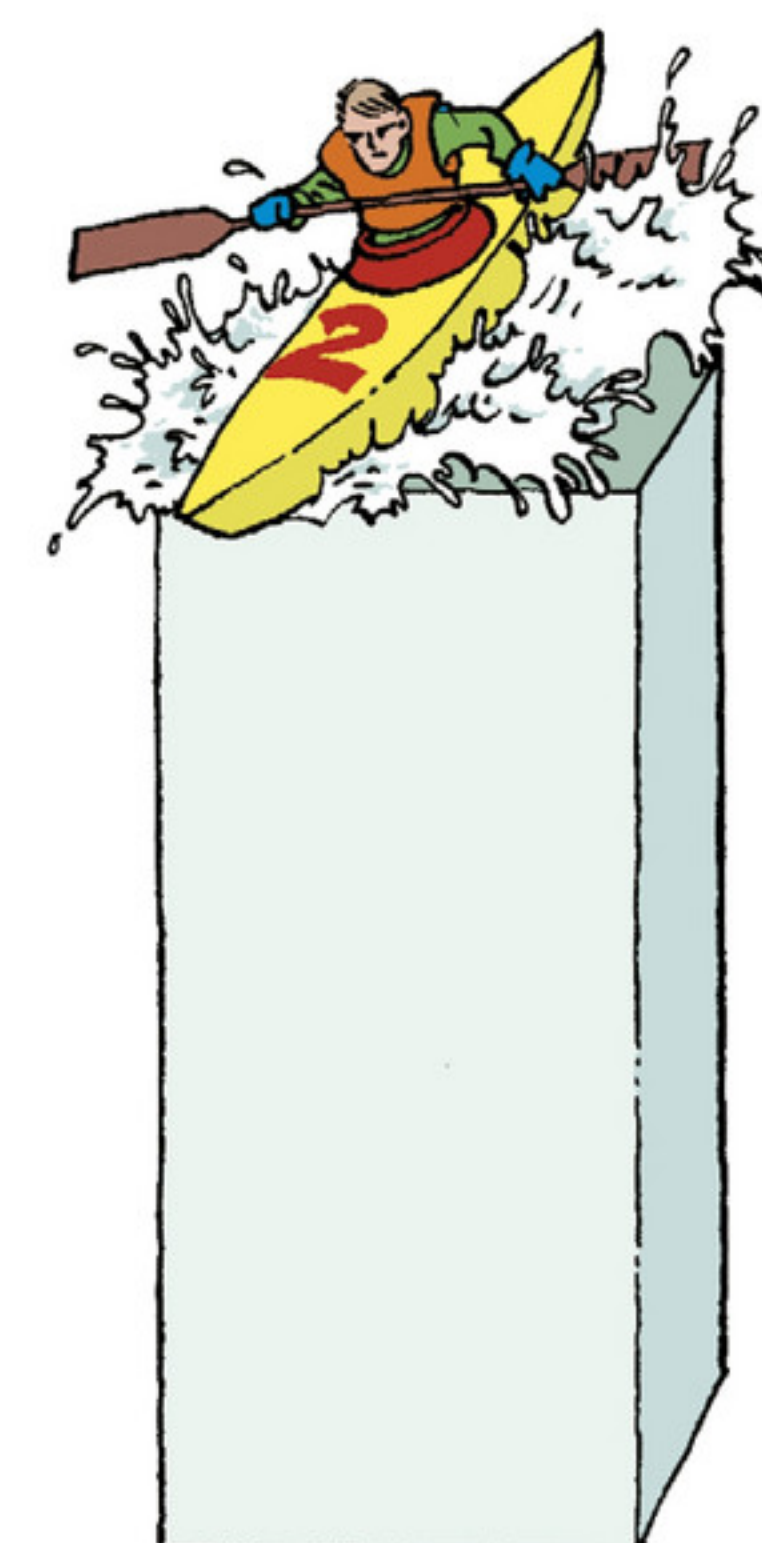
walking:
16.7 kJ per minute



jogging:
29.3 kJ per minute

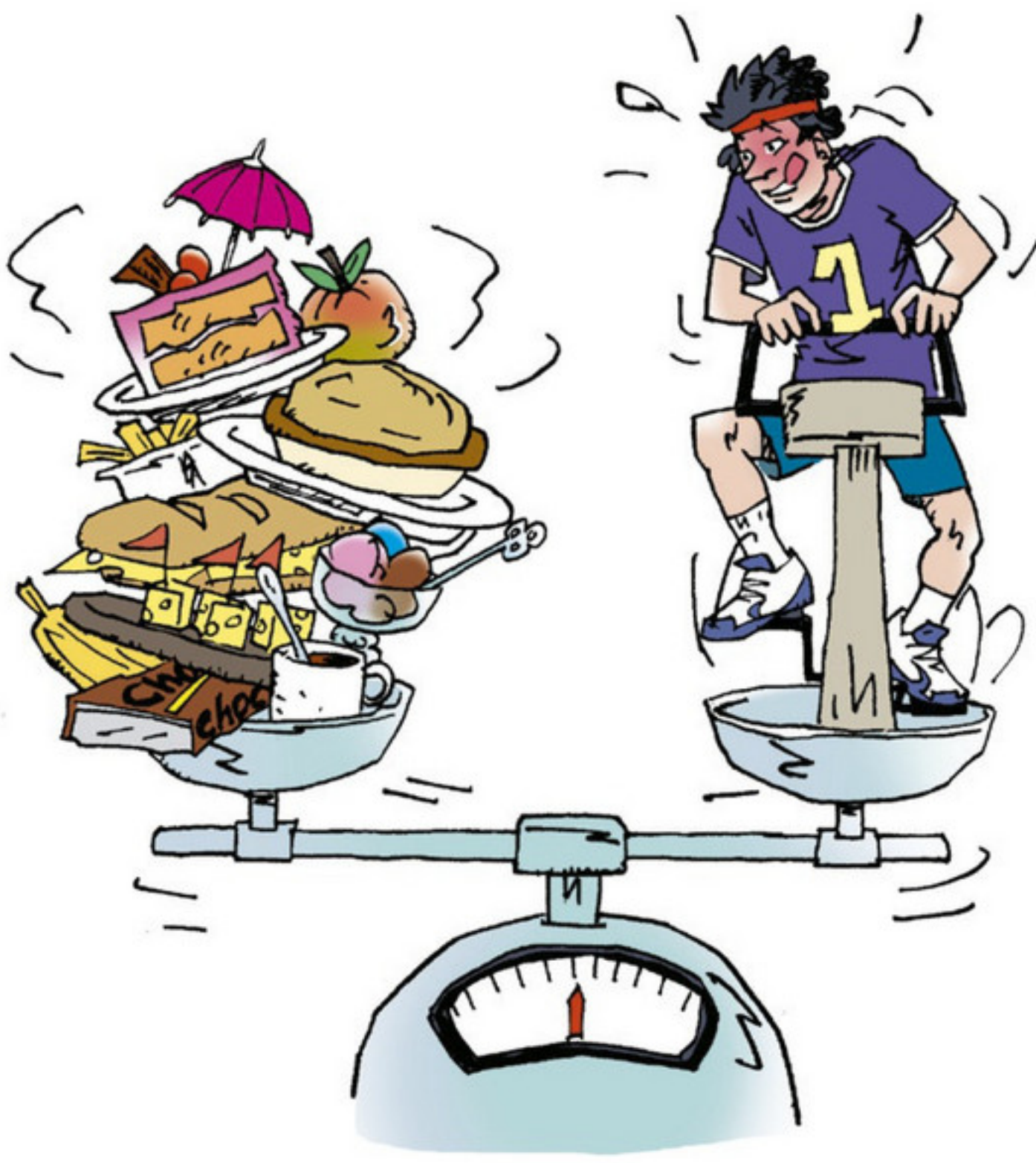


climbing stairs:
46.1 kJ per minute



rowing race:
54.4 kJ per minute

▼ Fig. 18 In balance?

**IN BALANCE?**

Your weight stays the same if your energy intake and your energy consumption are in equilibrium, i.e. if they are balanced (see figure 18).

A lot of people in the Netherlands do not have that balance. They eat too much and their food is too fatty and they do not exercise much. They therefore take in more energy in their food than they actually use. A proportion of these nutrients is then stored in the body as a food reserve (the fats above all). This is why a lot of people are overweight: they suffer from **overweight** (see figure 19). Your weight is also related to your natural **disposition** that you have inherited from your parents. Some people are simply more heavily built than others or have a thicker layer of fat.

People who are overweight have a greater risk of **cardiovascular disease** and a particular form of **diabetes** (type 2). Being overweight is also bad for your **joints**. Your joints are too heavily loaded, which means that complaints can arise more quickly, particularly in your back, neck, knees, ankles and feet.

▼ Fig. 19

One in seven young people is overweight

At the beginning of the 1980s, about 100 young people at a secondary school with 1400 pupils would be overweight. That figure is now 210. This is a worrying development, because the chance of being overweight only increases as you get older. The familiar 'couple of pounds a year' that you put on is therefore particularly risky for overweight youngsters.

Studies have shown that the risk of getting diseases is significantly higher if you are overweight. Getting enough exercise, joining a sports club, watching less TV, sitting behind the computer screen less, and eating less but more healthy foods are all recommended. It is particularly tough for some young people. If both parents are overweight, the likelihood of the

children also being overweight is nine times greater. A predisposition towards overweight also plays a part, and the eating habits at home have a big influence.



▼ Fig. 20 A swollen belly due to a lack of protein.



When your bodyweight is too low, you are said to be **underweight**. Being underweight is not healthy. People who do not get enough vitamins or minerals can get sick more easily or become anaemic. Being malnourished can also come from a lack of protein, particularly in developing countries. When small children do not get enough protein, their growth and development will be slower, their brains may be damaged and they may have a swollen belly (see figure 20).

YOUR WEIGHT

You can see if your weight is healthy by working out your **body mass index (BMI)**. You can calculate your BMI by dividing your bodyweight (in kilograms) by the square of your height (in metres).

The formula is:

$$BMI = \frac{\text{weight (kg)}}{\text{height}^2 (\text{m}^2)} = \text{kg/m}^2$$

Example:

Jack weighs 70 kg and is 1.73 m tall.

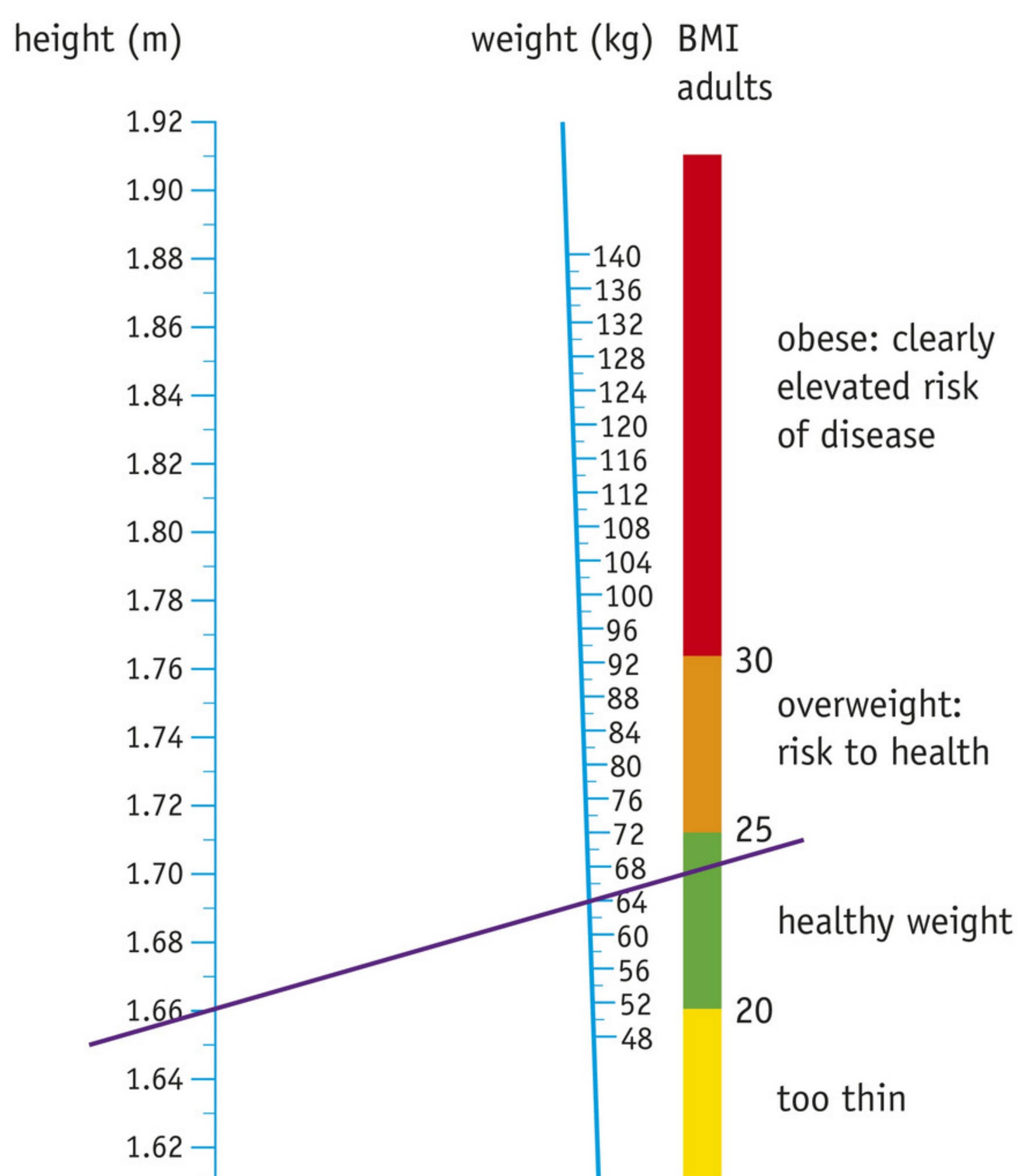
Height $\times$ height: $1.73 \text{ m} \times 1.73 \text{ m} = 2.9929 \text{ m}^2$.

$BMI = 70 \text{ kg} \div 2.9929 \text{ m}^2 = 23.4 \text{ kg/m}^2$.

Adults have a healthy weight if their BMI is between 20 and 25 kg/m^2 . At your age, you are still growing (a lot). You should therefore be very careful about drawing any conclusions from BMI data (see table 2). You can also read off the BMI in a diagram (see figure 21).

▼ **Fig. 21** Reading off the body mass index.

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WHAT DO YOU HAVE TO DO?

- 1 Find your height along the left-hand line.
- 2 Find your weight along the middle line.
- 3 Make a line between those two points using a ruler and extend that line.
- 4 Read the BMI off the coloured bar to see if your bodyweight is OK, or use table 2.
Note: variations of 1 or 2 kg in the bodyweight are normal.

▼ **Table 2** The body mass index for young people.

Age	BMI for boys			BMI for girls		
	12	13	14	12	13	14
Underweight	less than 15	less than 16	less than 16	less than 16	less than 16	less than 17
Healthy weight	15 to 21	16 to 22	16 to 23	16 to 22	16 to 23	17 to 23
Overweight	21 to 26	22 to 27	23 to 28	22 to 27	23 to 28	23 to 29
Severely overweight (obese)	more than 26	more than 27	more than 28	more than 27	more than 28	more than 29

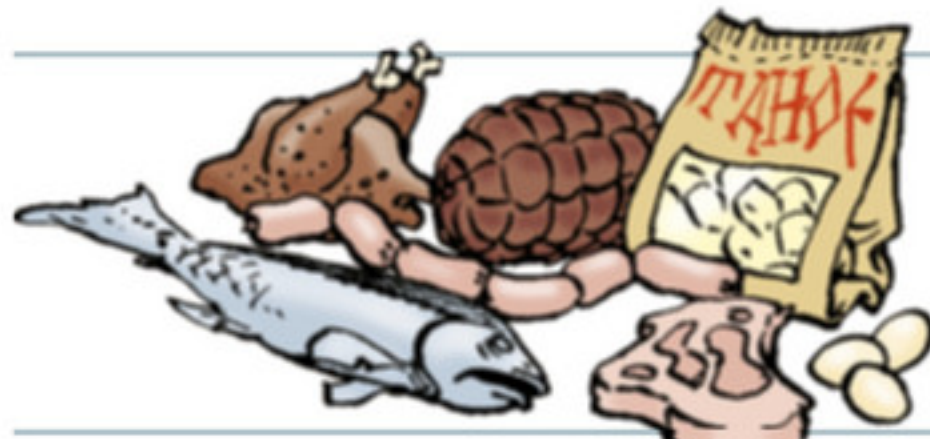
▼ Fig. 22 Recommended quantities of foodstuffs per day.



A HEALTHY AMOUNT

It is difficult to say exactly how much food is healthy for you. Figure 22 shows roughly what you need on average. You may need a bit more than that, or you may find a bit less is quite enough. You get most of the energy you need from your meals, but remember: snacks provide energy too (see figure 23).

To help you remember
What we need on average per day for a healthy diet

	Teenagers aged 12 to 18	Adults
 Bread	5 to 7 slices (or comparable quantities)	6 to 7 slices (or comparable quantities)
 Potatoes, rice, macaroni, spaghetti, pulses, couscous	4 to 5 pieces or 1 portion (200 to 250 g)	4 to 5 pieces or 1 portion (200 to 250 g)
 Vegetables	3 to 4 serving spoons (150 to 200 g)	4 serving spoons (200 g)
 Fruit	2 pieces of fruit	2 pieces of fruit
 Milk and dairy produce	4 glasses (600 mL)	3 glasses (450 mL)
 Cheese	1 slice (20 g)	1½ slices (30 g)
 Red meat, fish, egg, chicken, tofu, processed meats	100 to 125 g	100 to 125 g
 Light margarine on bread	5 g per slice of bread	5 g per slice of bread
 Margarine for preparation	15 g	15 g
 Drinks (including milk)	1 to 1½ L	1½ to 2 L

► Fig. 23 Snacks.



If you take in less energy than you need, your body starts using its reserves. Your bodyweight will go down as a result. Some people who are overweight start 'slimming' by eating less than the recommended amounts or skipping a meal. That is not a very good way of dieting. If you want to slim down, the best way is to pick one of the five methods shown in figure 24.

It is often not easy to know whether your own diet is in line with these recommendations for healthy eating. To be able to assess well whether your diet is healthy, you would have to keep track of precisely what you eat and drink for quite some time. To be able to make proper comparisons, you would also have to allow for your gender and bodyweight. You will be doing that in the workbook.

► Fig. 24

SLIMMING SENSIBLY

Method 1 is the least strict and method 5 is the strictest.

- 1 Eat normal quantities and get more exercise.
- 2 If you eat snacks, choose something with not much fat or carbohydrates.
- 3 Eat only the recommended quantities. This often means more bread, more fruit, more vegetables, less meat and less cheese.
- 4 Always eat the smallest quantities of the recommended amounts.
- 5 Do not eat any snacks at all in between meals. Do drink enough water, tea or coffee (with no sugar) or 'light' soft drinks. (Do not have 'light' soft drinks too often, though, because all soft drinks are bad for your teeth.)

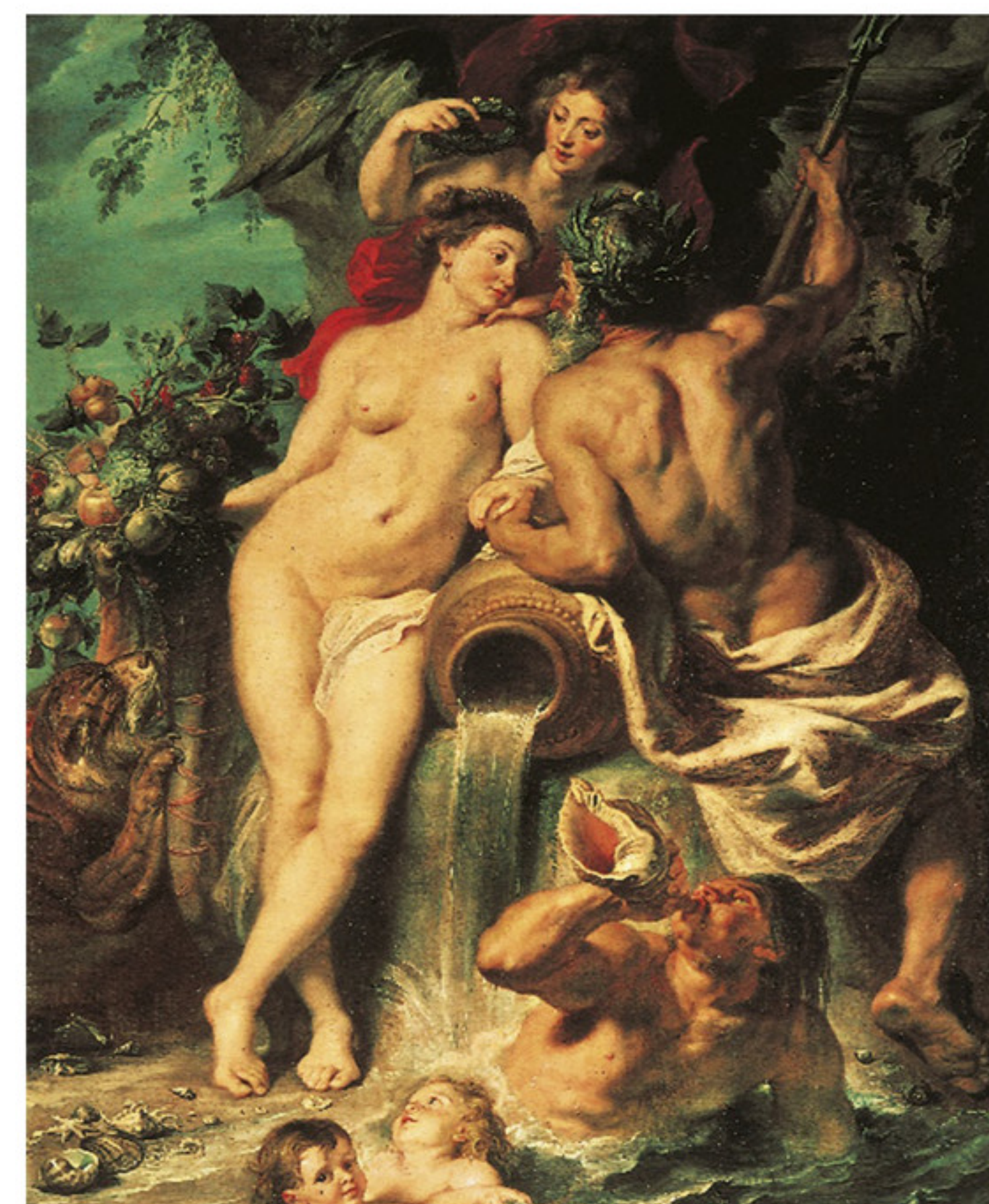
EATING DISORDERS

Some people lose too much weight and end up being severely underweight. This can have a variety of causes, such as a disease. But it generally happens because people want to look good, in line with the norms that are presented in magazines, on the Internet and on TV. Those norms are not always the same in all cultures (see figure 25).

► Fig. 25 Top models.



1 now



2 in the 17th century (Rubens)

▼ Fig. 26



Some people are not too fat, but feel as if they are (see figure 26). When people lose extreme amounts of weight and are very worried about putting on weight, they are suffering from **anorexia nervosa**. One danger of losing a great deal of weight is that you may not take in enough nutrients. Because you are not getting enough energy, you will in the end get listless and inactive. You can get all kinds of illnesses and problems with your stomach and your teeth. About 15% of people who are anorexic ultimately die from the condition. Anorexia nervosa is an example of an **eating disorder**. People with **bulimia nervosa** are also worried about being too fat and they also do not eat enough, but they do have regular eating binges. They then vomit to get rid of the food, or use large amounts of laxatives. People with **binge eating disorder (BED)** also have these moments when they eat a lot, but they do not vomit it back up or use laxatives. As a result, they put on a lot of weight. The various eating disorders can also appear at different times in the same person.

Eating disorders are seen mainly in adolescent girls and young women, but men and boys can get them as well. The causes of eating disorders are often psychological. People with eating disorders generally have a negative opinion of themselves, their bodyweight and their appearance. Following a diet therefore does not help. It is important for someone with an eating disorder to get intensive support from experts as soon as possible. The chance of recovering is then highest. A confidential talk with their GP is a good start.

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▼ Fig. 27

Dietician

Hello. I'm Karen and I'm a dietician at a health centre. I work there with patients who need advice because of their illnesses. These are people with diabetes, for instance, or who are overweight or underweight. I also give advice to healthy people who want to take a fresh look at their diet, for example a woman who is pregnant or someone who wants to slim down sensibly. In the first consultation, we discuss why people have come to me. We go through their eating habits and then look to see exactly what the problem is. Then we look to see what can be done about it and draw up a treatment plan. In the follow-up consultations we discuss how things are going and we think of solutions for the issues that are encountered.



5 Thinking about food

▼ **Fig. 28** Malnutrition.



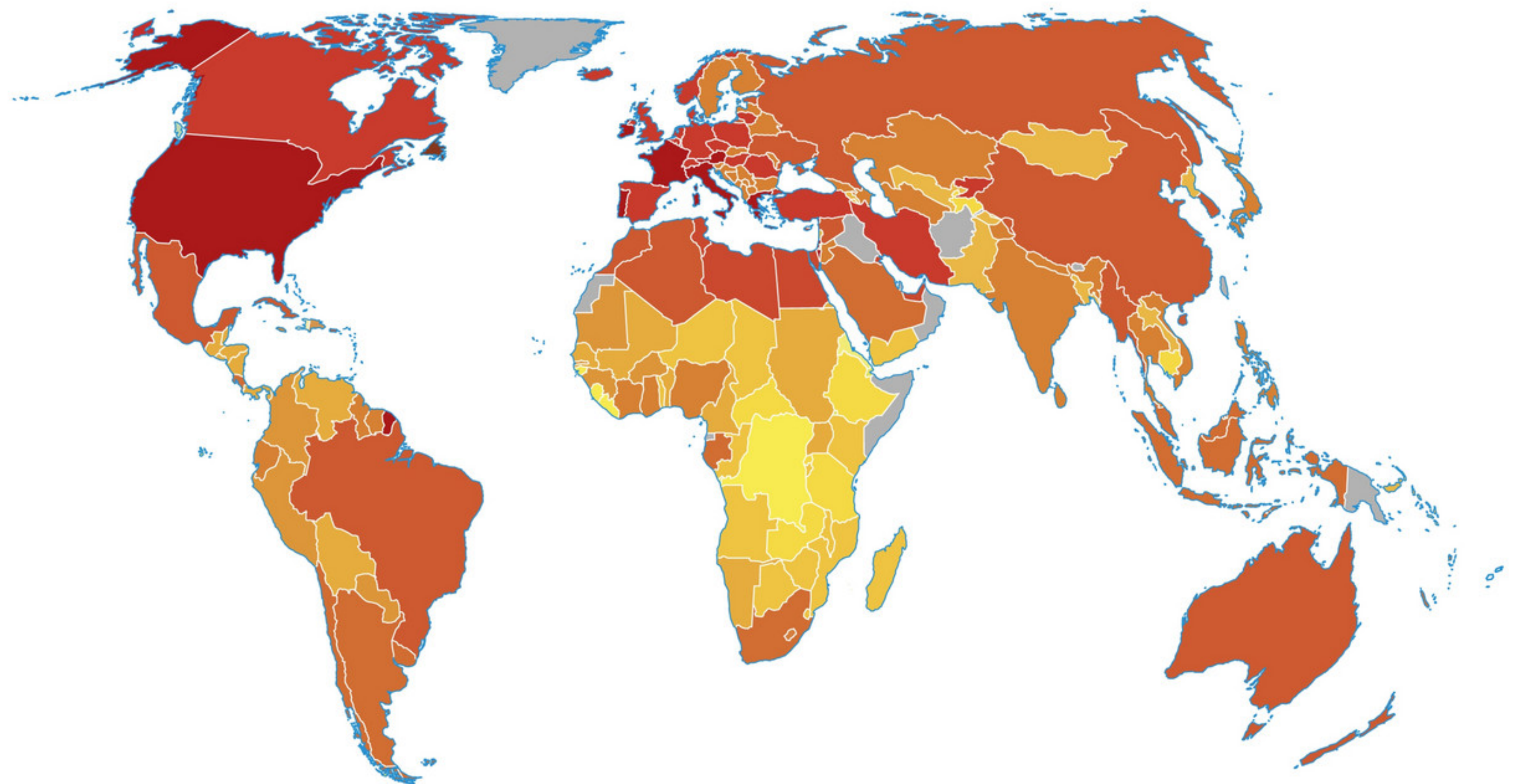
There is enough food in the Netherlands for everyone and nobody needs to go hungry. That is not true in all the world's countries. In developing countries in particular, a lot of people are malnourished. These people never eat enough, because there is not enough food around or because they are not able to buy enough food.

The minimum amount of energy that an adult needs to stay alive is roughly 7100 kJ (1700 kcal) per day. And that is only enough for someone who is almost inactive. An adult who is working physically hard needs at least 14,000 kJ (3400 kcal) per day. And it is particularly in developing countries that people have to do a lot of hard physical work, because there is little or no machinery (e.g. for agriculture).

The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) have calculated that an average of 9450 kJ (2250 kcal) per day is needed to live a normal life and work.

Figure 29 shows how much energy the people living in various countries throughout the world get on average per day.

▼ **Fig. 29** Average number of kJ in the daily food per head of the population.



Legend:

< 6700 kJ	12,000–13,000 kJ
6700–7500 kJ	13,000–14,000 kJ
7500–8400 kJ	14,000–15,000 kJ
8400–9200 kJ	> 15,000 kJ
9200–10,000 kJ	no data
10,000–11,000 kJ	
11,000–12,000 kJ	

There are still countries where people (mostly children) die of hunger. That is despite there being enough food for everyone on the planet. The food is however not equally distributed. There are countries where so much food is produced that some of it has to be destroyed. That happens in the Netherlands too. Sometimes good, healthy food gets used as animal feed.

People in developing countries are much more dependent on nature than in the Netherlands. We can grow products in greenhouses. We can store food, for example in grain silos and large deep-freeze warehouses. And our crops will never fail completely. We also have good **transport capabilities**, so that we can quickly fetch food from other sources. That may all be quite different in developing countries. Crops there fail regularly, for example because of lengthy droughts. In those emergency situations, we help by giving money for all kinds of interventions. This has saved many people from dying of hunger. But it is above all important that the people in developing countries should be able to look after themselves, with good **agricultural methods** so that the harvest will not fail so quickly again and with good transport capabilities.

Malnutrition is not only caused by having too little food. Deficiencies of particular nutrients can also cause malnutrition. In developing countries in particular, malnutrition can be the result of a lack of protein (see figure 30). If there is not enough protein in their food, people will start feeling weak and tired. They may then no longer be interested in working and learning. In time, they will become ill. Malnutrition does also occur in developed countries (see figure 31).

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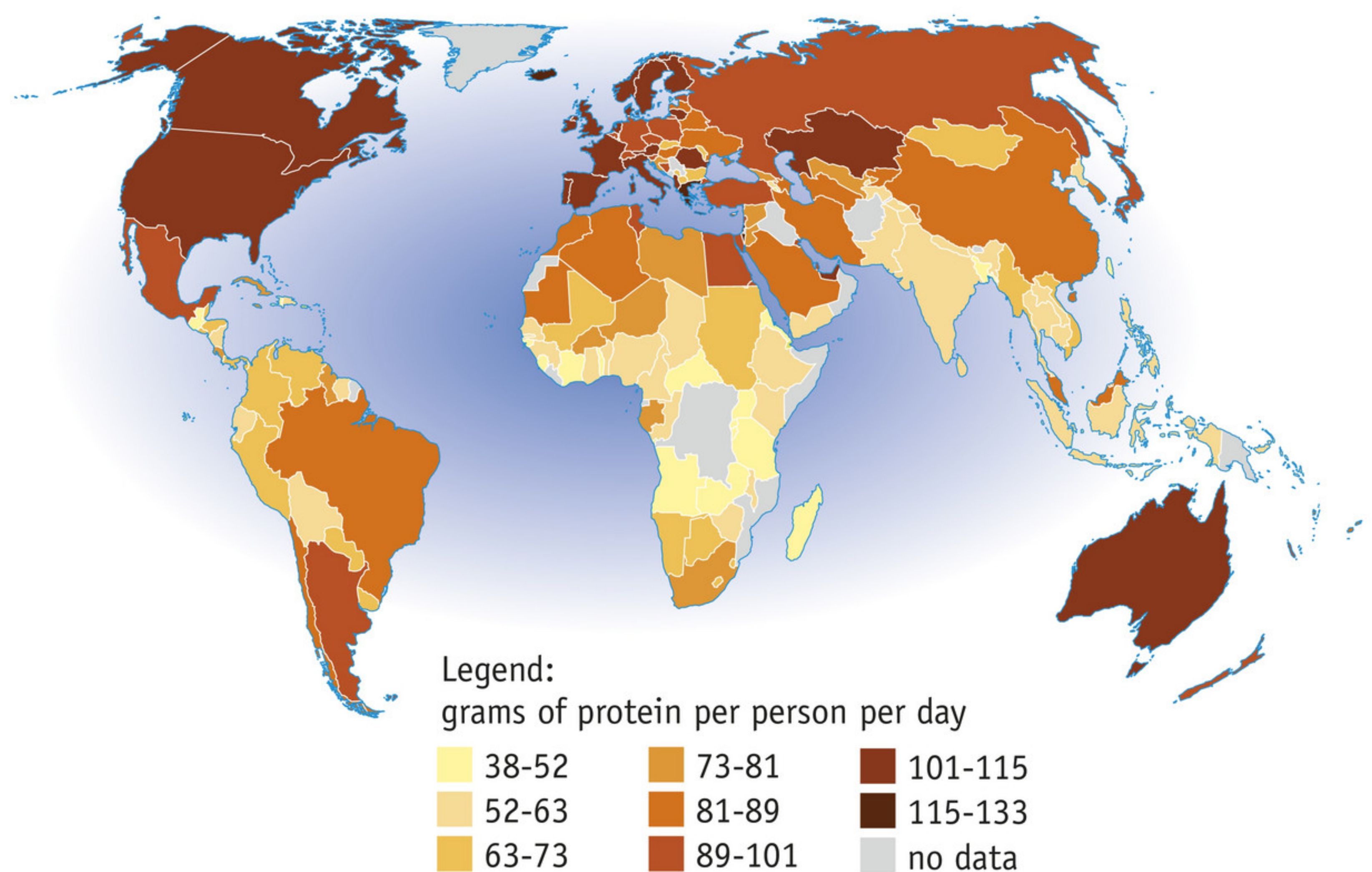
▼ Fig. 31

Malnourished by junk food

Some people love junk food such as hamburgers, chips, sausages, crisps, cakes and sweets. Nice, perhaps. But not healthy. If you eat too much of these, the chance that you will end up malnourished increases. This is because junk food contains very little in the way of nutrients such as vitamins and minerals, and has a lot of fat instead. Mild forms of malnutrition can quickly lead to hair loss, lethargy, loss of muscle mass and eating binges.



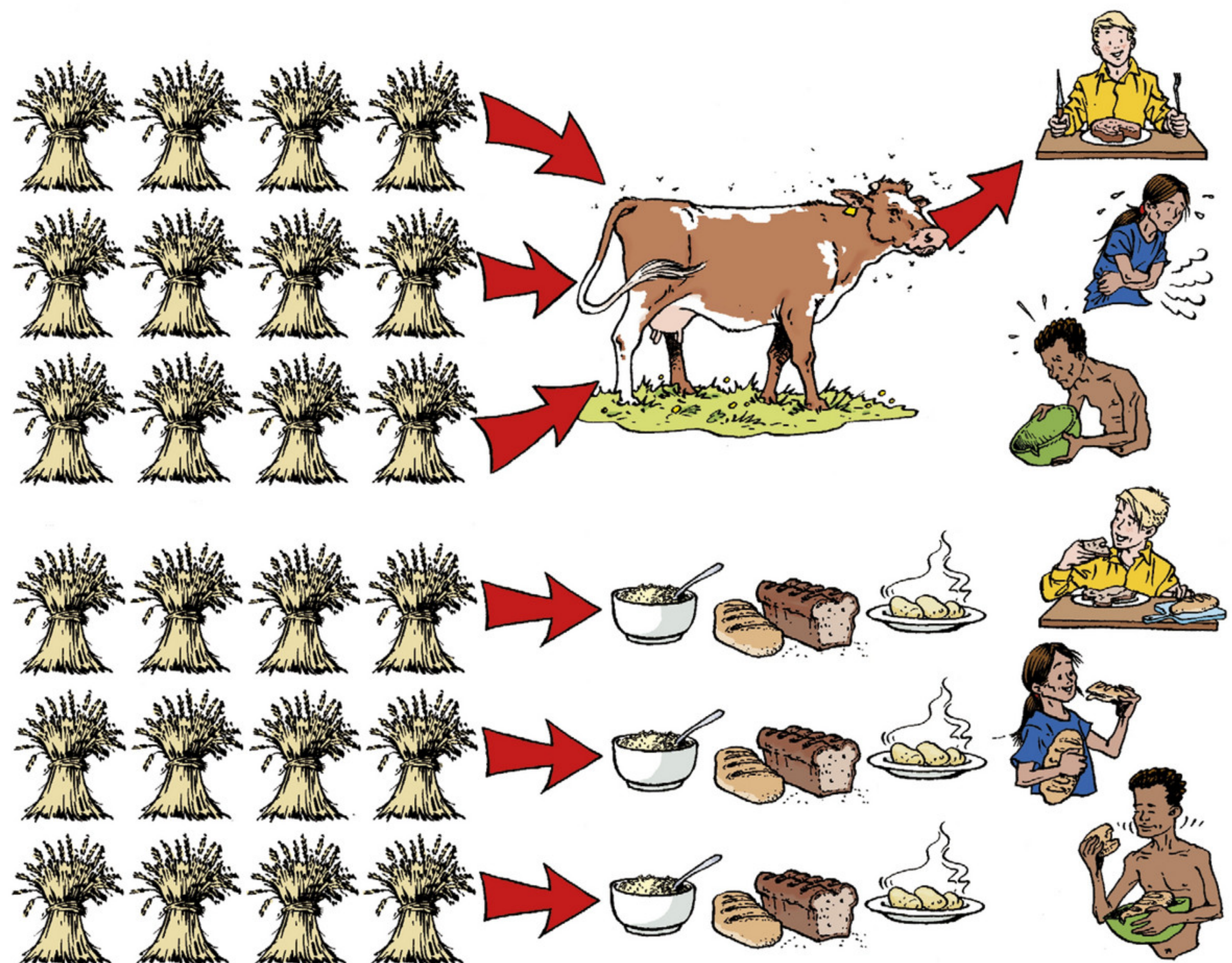
▼ Fig. 30 Daily protein intake (grams per person per day).



VEGETARIANISM

Vegetarians do not eat food that is obtained by killing animals. Some 'vegetarians' will not eat the meat of mammals or birds, but will eat fish and other marine animals. **Vegans** do not eat any animal products at all. There are various reasons for not eating meat (or for eating less meat). Some people are vegetarians out of respect for animals. They are against killing animals or against the way that animals are kept and treated in the farming industry. Others are vegetarians for health reasons, for example because meat contains fats or the residues of medicines. Increasing numbers of people distrust meat because of diseases such as swine fever, mad cow disease and foot and mouth. Some people are vegetarians because of their religious beliefs. You may also choose to eat little or no meat for the sake of the environment. You will learn more about the negative effects of livestock farming on the environment in unit 7 (Humans and the environment). Some people are vegetarians because it is better for the food situation worldwide. For every kilogram of animal protein that an animal gives, that animal may have eaten as much as 10 kilograms of plant protein. We cannot eat grass though, can we? That is true, but products could be grown on parts of that grassland that we could eat (see figure 32). Finally, there are people who do not eat meat because they do not like it (the taste) or because they think it is too expensive (the price).

► Fig. 32



If you replace meat with other high-protein products, you will consume less fat and more carbohydrates. One disadvantage is the body absorbs iron from these foodstuffs less easily. Vitamin C helps the body absorb iron. This is why you must eat plenty of fruit and vegetables if you are a vegetarian. Vitamin B12 hardly occurs at all in plant-based foodstuffs, although it is present in milk and dairy products. There are also vitamin B12 tablets that vegetarians can buy.

Meat substitutes can now be found in most food shops. These products often look like meat – not only in their outward appearance, but also in taste, texture and nutritional value. Meat substitutes are rich in iron, protein and B vitamins. Most of them are made from soy beans or from grain proteins (see table 3). Valess is made from milk and Quorn from a fungus that is related to mushrooms (see figure 33). The food situation worldwide and the environment may also benefit if we switch to other forms of meat (see figure 34).

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▼ **Table 3** Nutrient content of meat and vegetarian alternatives.

	Protein (per 100 g)	Iron (per 100 g)	Vitamin B1 (per 100 g)	Vitamin B12 (per 100 g)
Egg (boiled, average)	12.9 g	2.1 mg	0.01 mg	1.1 µg
Mince (pork/beef mix)	17.5 g	1.5 mg	0.18 mg	1.5 µg
Cheese (48%+ fat on average)	24.5 g	0.3 mg	0.03 mg	1.5 µg
Nuts (mixed)	22.7 g	3.3 mg	0.18 mg	0.0 µg
Pulses (beans, prepared)	7.5 g	2.0 mg	0.0 mg	0.0 µg
Quorn	14.0 g	0.7 mg	0.10 mg	0.2 µg
Steak	28.3 g	2.0 mg	0.04 mg	1.8 µg
Seitan	22.1 g	1.9 mg	0.03 mg	0.0 µg
Tofu	12 g	2.0 mg	0.06 mg	0.0 µg

▼ **Fig. 33** Meat substitutes.



▼ **Fig. 34**

Hamburger of cultured meat presented

In 2013, the Dutch scientist Mark Post presented the first hamburger to be made of cultured meat. The hamburger consisted of 40 billion cells that were grown in a laboratory in Maastricht, starting from cells from a cow. It took three months to grow these cells to produce a piece of meat. The cultured meat costs about 250,000 dollars per 100 g. Post and his staff isolated certain cells from cows. These cells were about to grow into muscle cells. In a Petri dish, they were submerged in a liquid containing proteins and sugars from animal blood. The scientists also mixed the cells with a gel that provided support for the tissue to grow on. The first cultured hamburger contains no fat yet, so the meat tastes less juicy. If Post gets his way, mass production of cultured meat will become a possibility. “It may take ten more years, but I think that cultured meat will in the end be available on the supermarket shelves.”

Source: www.nu.nl.

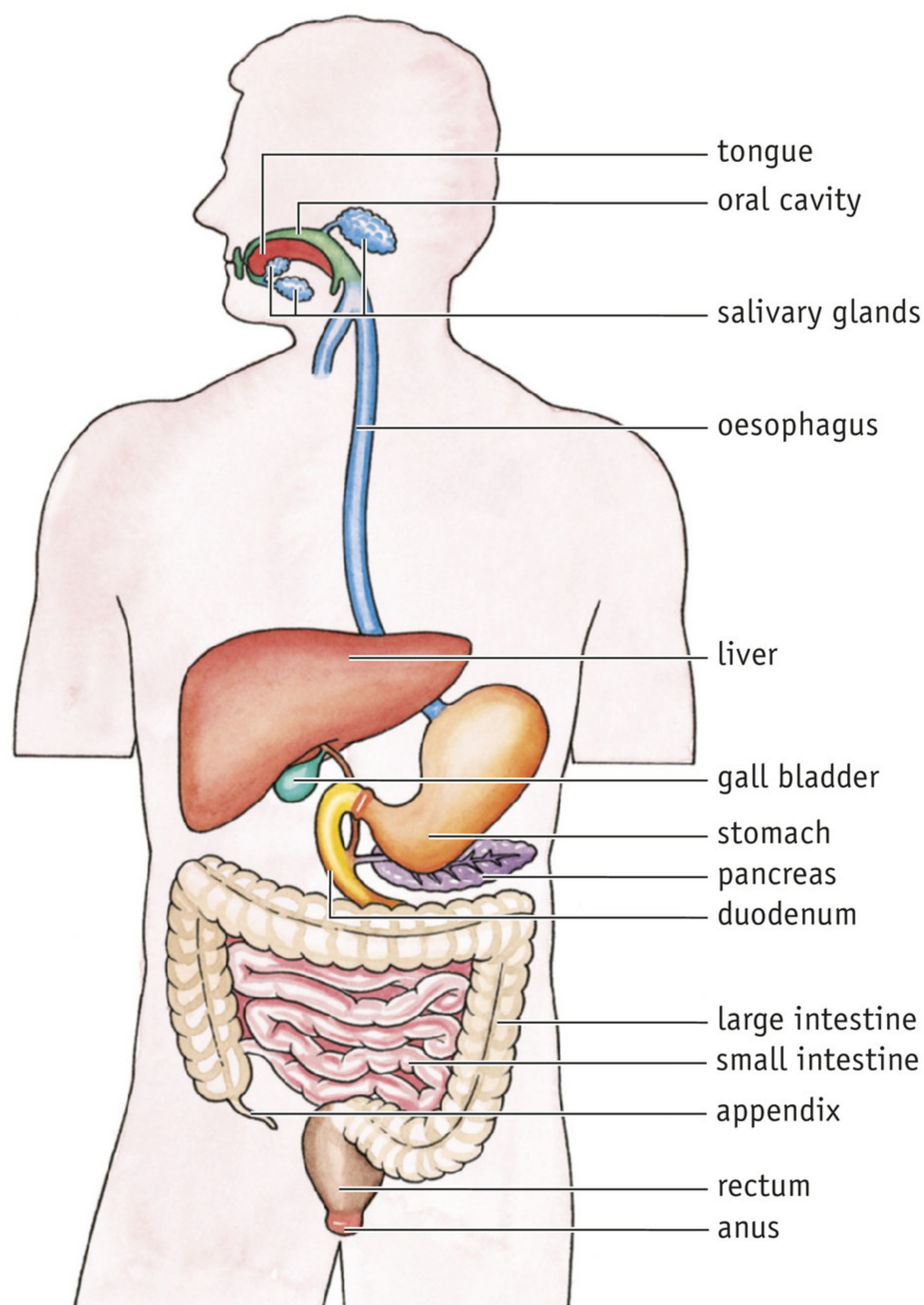


6 The digestive system

Figure 35 shows a schematic drawing of the human digestive system. The digestive system consists largely of a long series of tubes from the mouth to the anus: the **intestinal tract**.

The digestive system is where nutrients from the food are absorbed into the bloodstream. Some foodstuffs can pass through the wall of the intestines and be taken up into the blood. Examples are glucose, minerals, vitamins and water. Other nutrients cannot pass through the intestinal wall and be taken up into the blood. Examples are proteins, most carbohydrates (such as sugars and starches) and fats. These nutrients have to be digested first. They are then converted into **digestion products** that can be absorbed into the blood. **Digestion** is the conversion of nutrients that cannot pass through the wall of the gut into the blood into digestion products that can be absorbed into the bloodstream.

► **Fig. 35** The human digestive system (schematic).

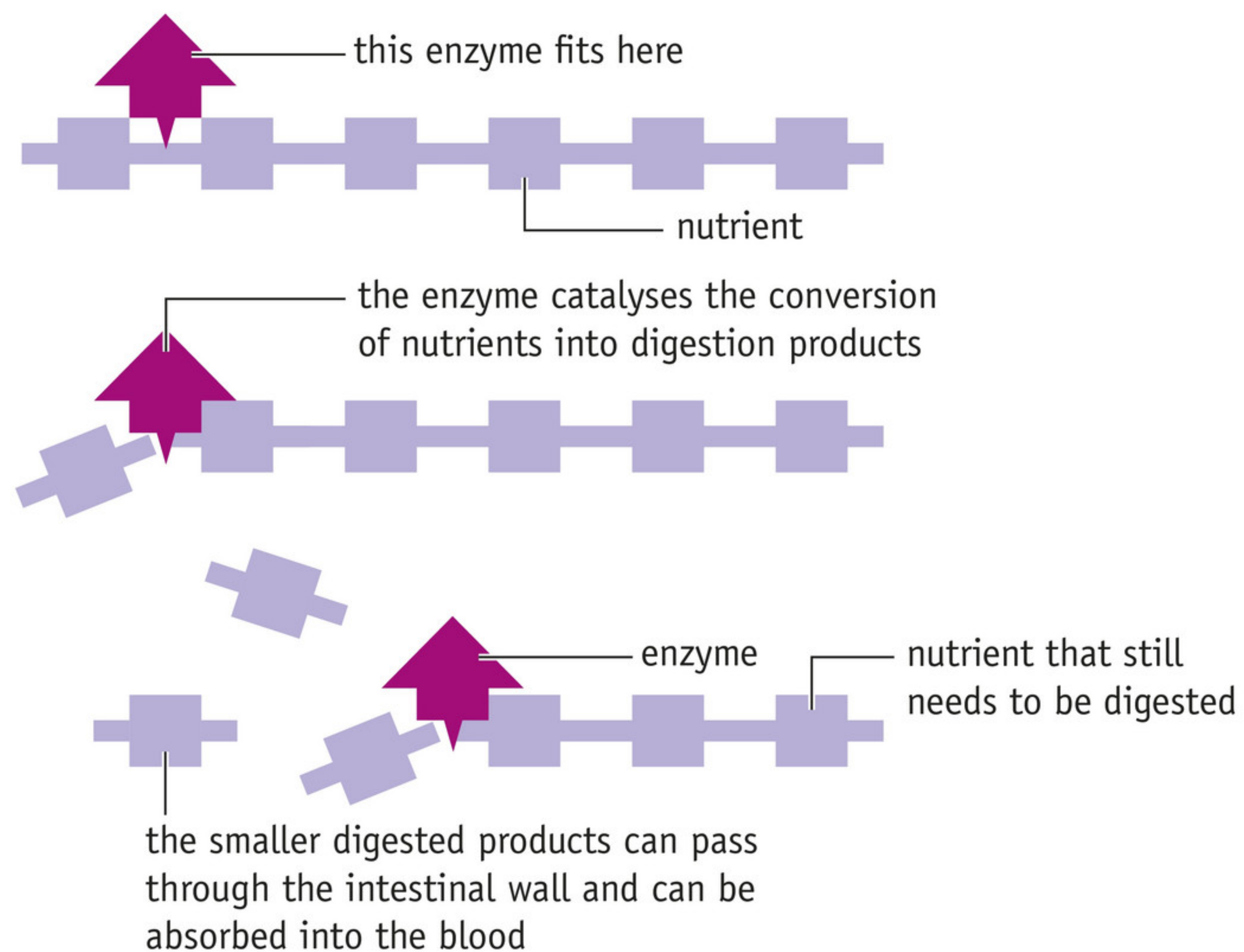


DIGESTIVE JUICES

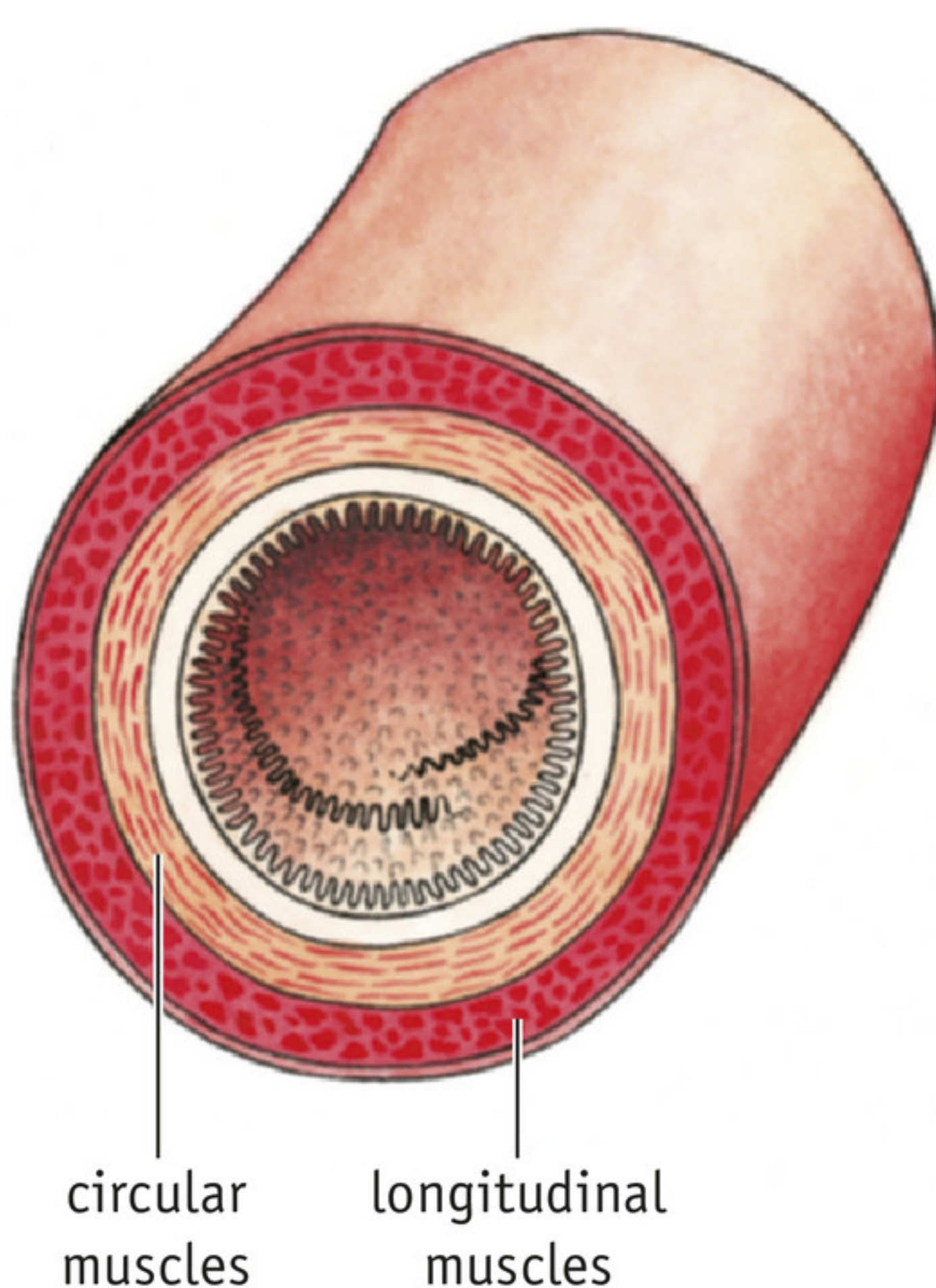
Digestion is done by **digestive juices**. Saliva and gastric juice are examples of digestive juices. Digestive juices are made by the **digestive glands**. The digestive glands in humans are the salivary glands, glands in the stomach lining and intestinal wall, the liver and the pancreas.

Various chemical processes take place during digestion. Nutrients are converted into other chemical compounds (the digestive products). Many digestive juices contain **enzymes**. The enzymes in digestive juices make sure that digestion proceeds quickly (see figure 36). Not everything in the food can be digested. Undigested residues (such as dietary fibre) are then passed out of the body through the anus.

► **Fig. 36** Enzymes help convert nutrients into digestion products.



▼ **Fig. 37** Circular muscles and longitudinal muscles (schematic).

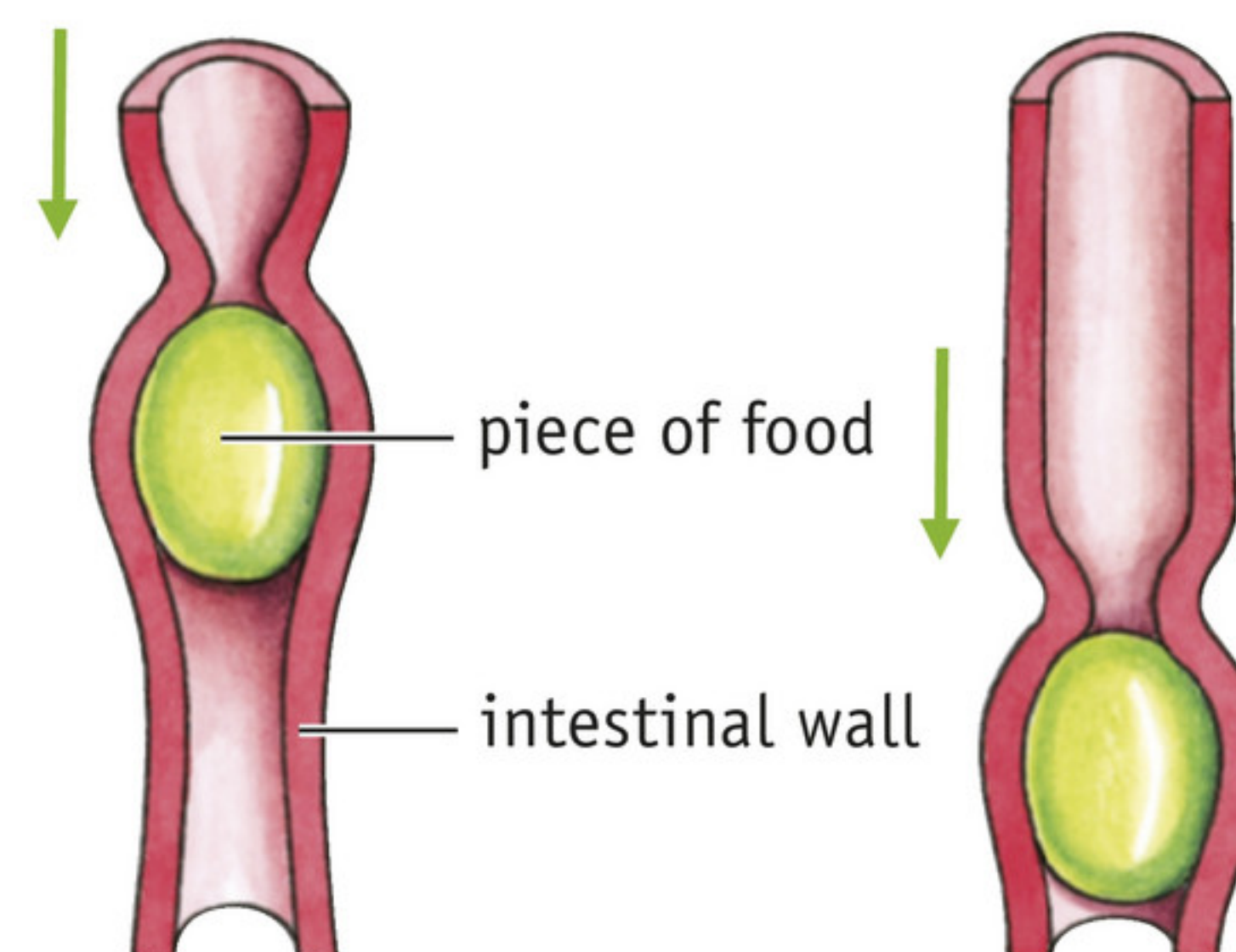


PERISTALSIS

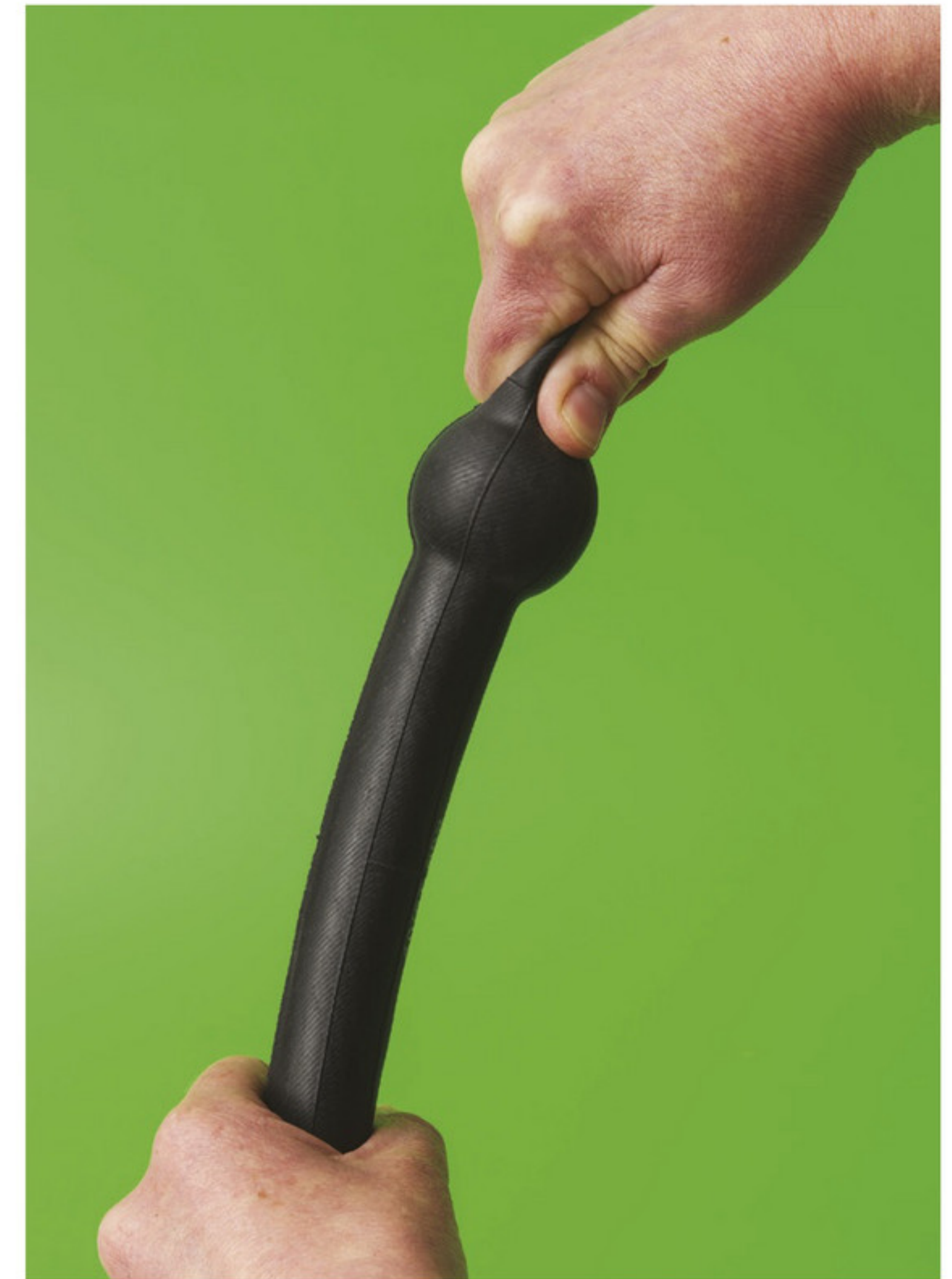
Along the wall of the whole intestinal tract, there are **circular muscles** and **longitudinal muscles** (see figure 37). As these muscles alternately contract, they create series of **peristaltic movements** that as a whole are referred to as **peristalsis**. Peristalsis moves the food along the intestines, kneading it and mixing it thoroughly with the digestive juices as it goes.

Figure 38 shows you how peristalsis works. Just in front of a lump of food, the circular muscles relax and the longitudinal muscles contract. That makes the gut wider at that point. Just behind the lump of food, the circular muscles contract and the longitudinal muscles relax. That makes the gut narrower at that point. Peristaltic movements can be imitated using a bicycle inner tube and a ping-pong ball (see figure 39).

▼ **Fig. 38** Peristalsis (schematic).



▼ **Fig. 39** Simulation of peristaltic movement.



A healthy diet contains a lot of products that are rich in dietary fibre. Dietary fibre stimulates the muscles in the gut wall, particularly in the large intestine. This improves peristalsis and helps the bowel movements (avoids constipation).

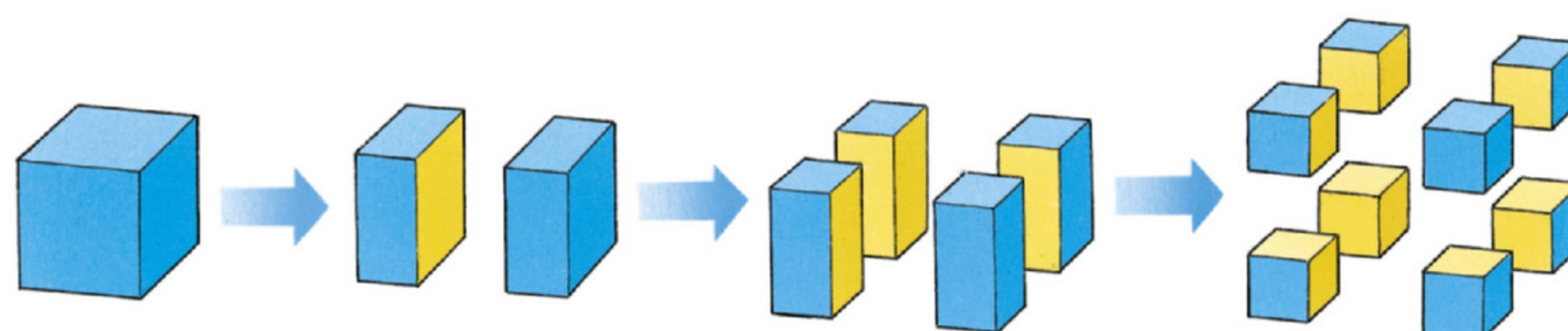
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7 The teeth

You use your teeth to chew up your food. This breaks your food down into small pieces, making it easier to swallow. Chewing also has a digestive function: because the food has been broken into little pieces, the surface area is larger (see figure 40). The enzymes in the digestive juices are then able to act on a larger food surface area. This lets the enzymes get at the nutrients in the food more easily.

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▼ Fig. 40 Increased surface area due to chewing (schematic).



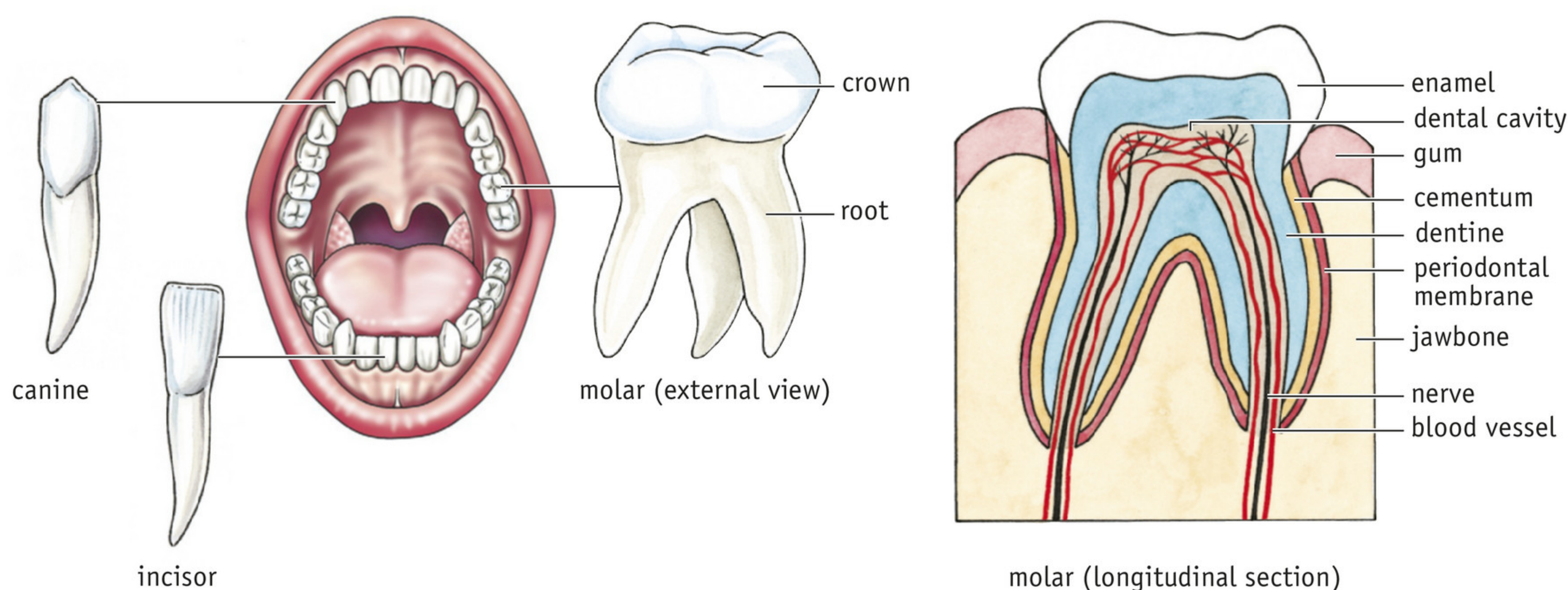
DENTAL ANATOMY

You have probably noticed that you have different kinds of teeth such as incisors and molars. Teeth have one or more **roots** to fix them in the upper or lower jaw (see figure 41). The part of the tooth that you can see sticking out of the jaw is called the **crown**.

A tooth consists mostly of **dentine**. The dentine of the crown is covered in a layer of **enamel**, which is extremely hard. The dentine of the roots is covered with a thin layer of **cementum**. Inside the dentine is the **pulp**, which is where the blood vessels and nerves are.

Around the roots is the **periodontal membrane** that attaches the tooth in the jawbone. The jaws are covered by the **gums**.

▼ Fig. 41 Teeth.



▼ Fig. 42



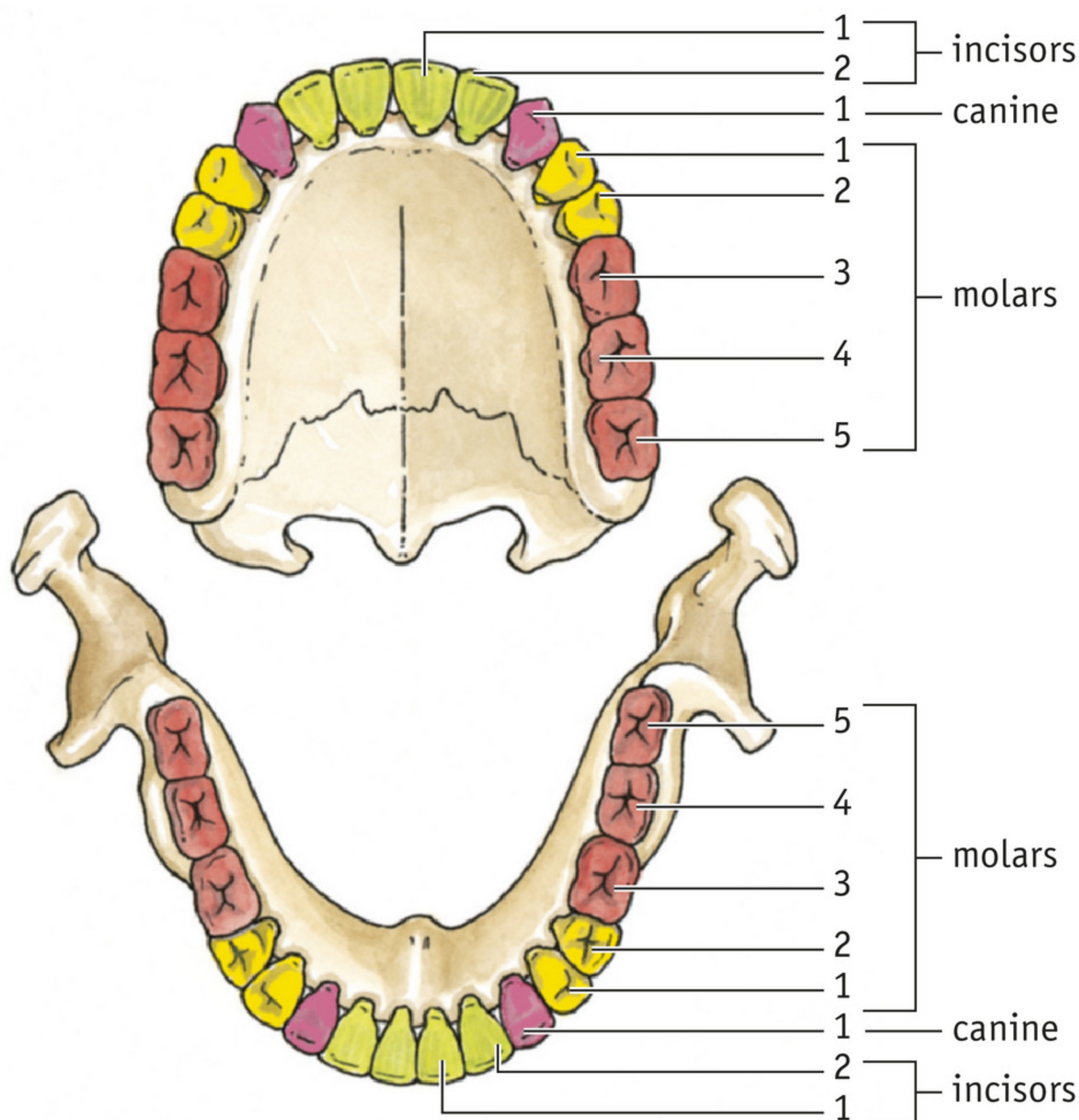
The **incisors** and **canines** are used for cutting off pieces of food. Predatory animals use the canines for gripping onto their prey (see figure 42). In humans, the canines are only a little bit more pointed than the incisors (see figure 41).

Molars have a knobby top surface (see figure 41). This lets you grind the food up small between the molars. At your age, you probably have four molars in each half of the jaw (see figure 41). You may grow another molar later in each half of the jaw. These are called **wisdom teeth**. The wisdom teeth are often too small for chewing food properly. It is also possible that they may not appear at all, or that they have to be taken out shortly after they do appear.

DENTAL FORMULA

Figure 43.1 shows the upper jaw and lower jaw of an adult with a complete set of teeth. The number of teeth someone has can be expressed in what is called the **dental formula** (see figure 43.2). The numbers state how many incisors, canines and molars there are. The numbers above the horizontal line refer to the teeth in the upper jaw and the numbers below the horizontal line refer to the teeth in the lower jaw. The vertical line marks the middle point. The numbers on the left represent the right-hand half of the jaw and the numbers on the right are for the left-hand half.

▼ Fig. 43



	upper jaw		
right jaw	5 . 1 . 2	2 . 1 . 5	left jaw
halves	5 . 1 . 2	2 . 1 . 5	halves
	lower jaw		

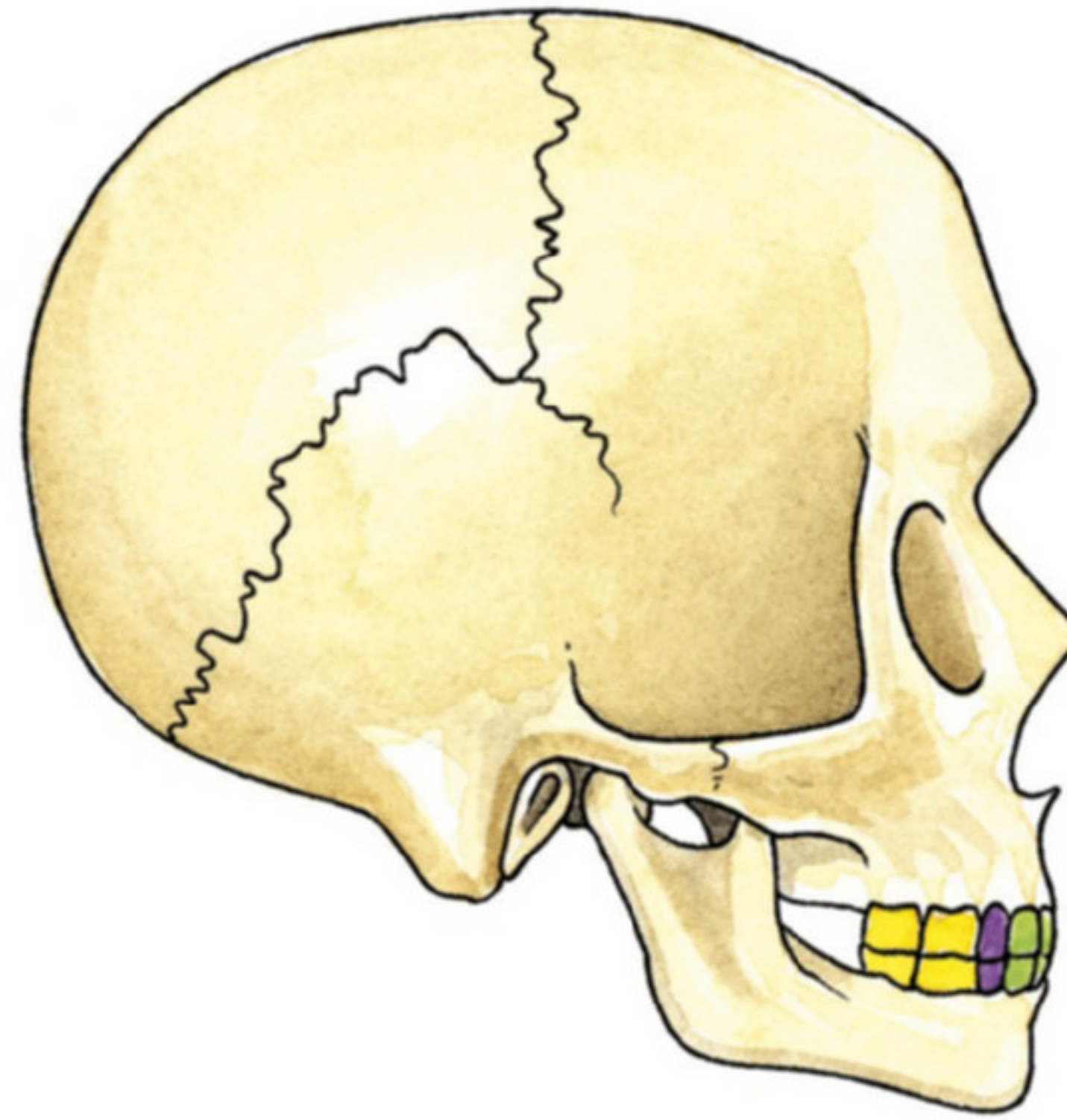
1 upper jaw and lower jaw of an adult with a complete set of teeth

2 dental formula for these teeth

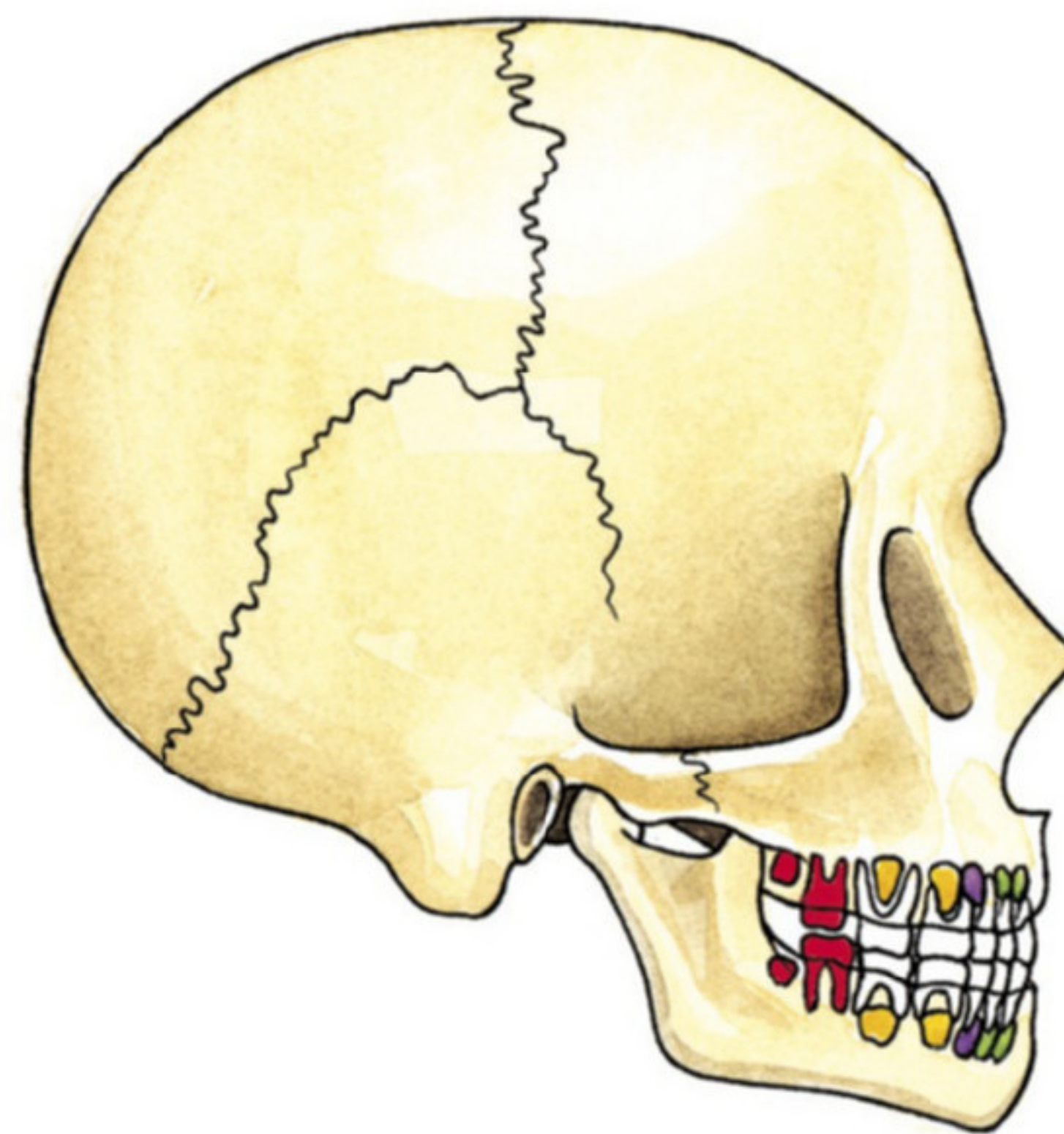
A new-born baby does not generally have any teeth yet. The first set of teeth – the **milk teeth** – appear between six months and two years (see figure 44). From about six years of age, the milk teeth are replaced by the **permanent teeth**. This is known as the **eruption** of the permanent teeth. Three molars also appear at this time (see figure 45).

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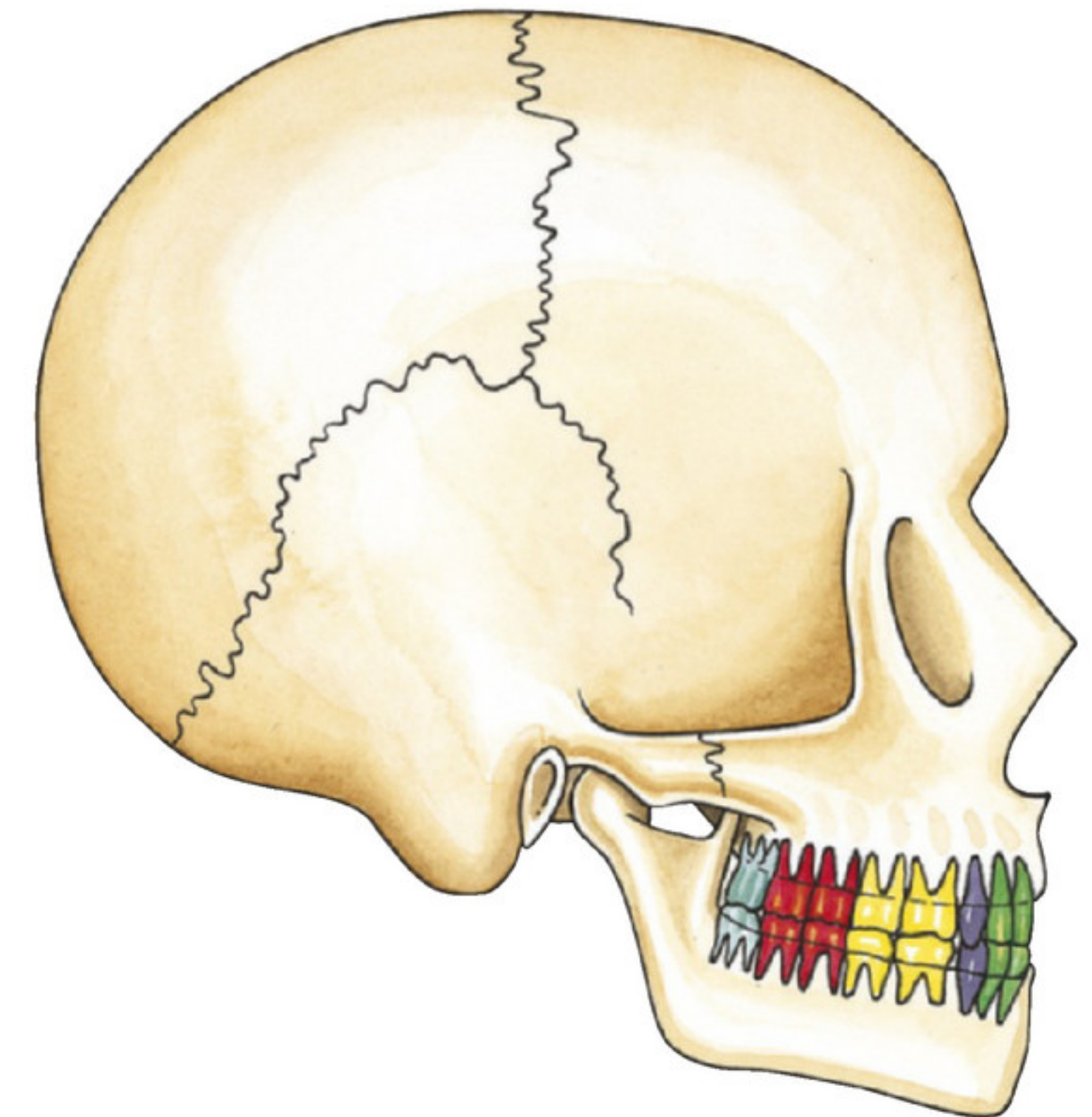
▼ **Fig. 44** Milk teeth (schematic).



▼ **Fig. 45** Eruption of the permanent teeth (schematic).



1 permanent teeth coming through



2 permanent teeth

DENTAL CARE

If your teeth are to stay healthy, you need to brush them thoroughly at least once a day. Figure 46 shows you how to do this properly. Brushing removes the plaque from your teeth. **Plaque** is a thin layer that is deposited on your teeth every day. It consists of residues of food, saliva and a lot of bacteria. The bacteria in plaque convert the sugars in your food into acids, which dissolve a tiny bit of the enamel each time. The bacteria mostly produce these acids as you eat, or shortly afterwards. Many soft drinks also contain acids that can damage tooth enamel.

▼ **Fig. 46** Brushing your teeth properly.

HOW TO BRUSH YOUR TEETH PROPERLY

Toothbrush

A good toothbrush is soft and has a small head. Once the bristles of the toothbrush start to get spread out instead of parallel, it should be replaced. That means they last about three months.

Toothpaste

Use fluoride toothpaste. A blob the size of a pea is enough. It won't produce too much foam then, and it's still enough to clean properly.

How often should you brush and for how long?

Brush your teeth twice a day for at least two minutes each time, in the evening before going to bed and in the morning after breakfast. One thorough clean is better than quickly brushing them more often.

How to brush

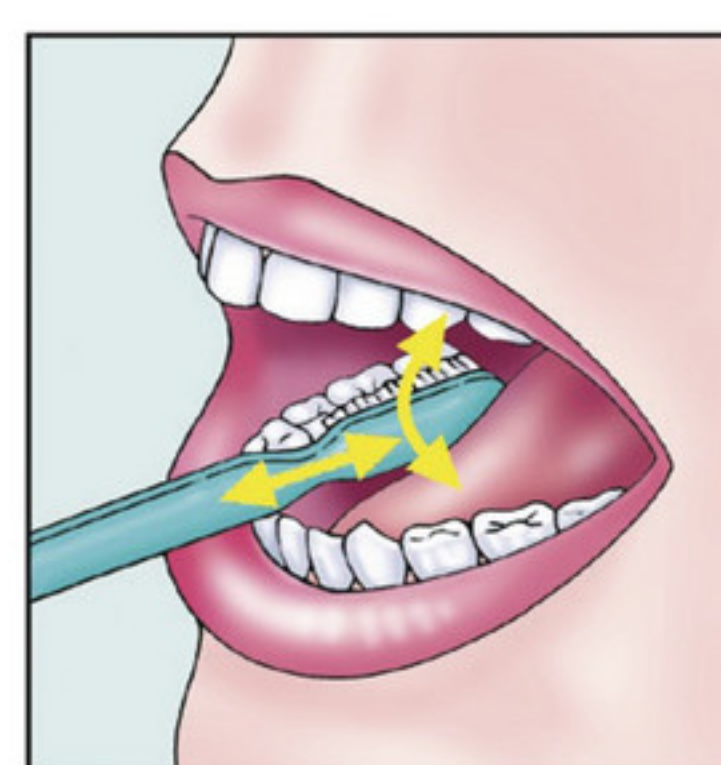
Use short brushing movements. Brush the inside, outside and chewing surfaces of your teeth, using a fixed sequence all the time so that you do not miss any bits. It is important to brush the area where your teeth and gums meet, because this is where plaque can easily get left behind. When you are brushing the inner and outer surfaces of your teeth, be careful to keep the toothbrush at right angles to the line where the teeth meet the gums (see image at left below).

Electric toothbrushes

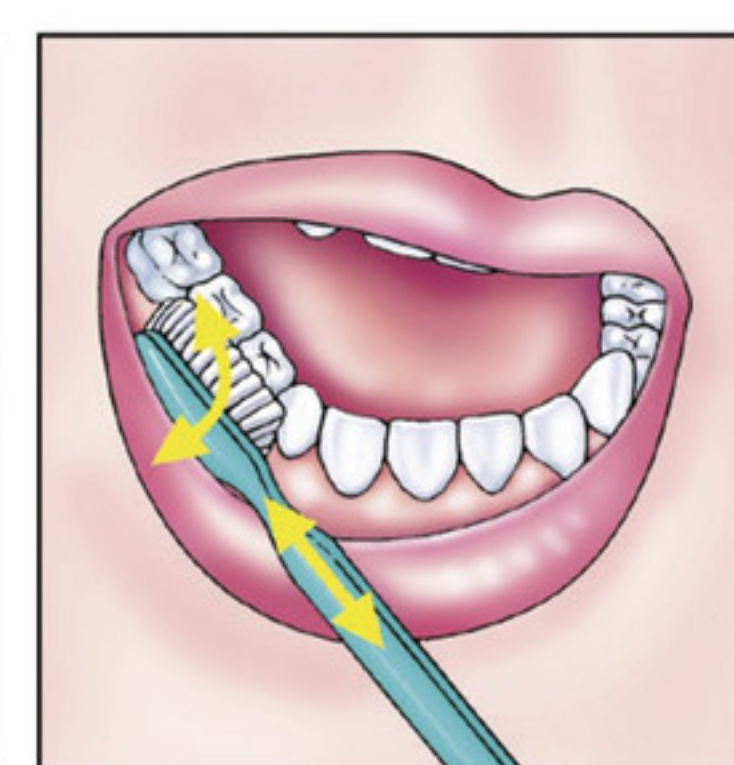
An electric toothbrush makes the brushing movements for you, so it can be a handy tool to help.

Dental, toothpicks or interdental brushes

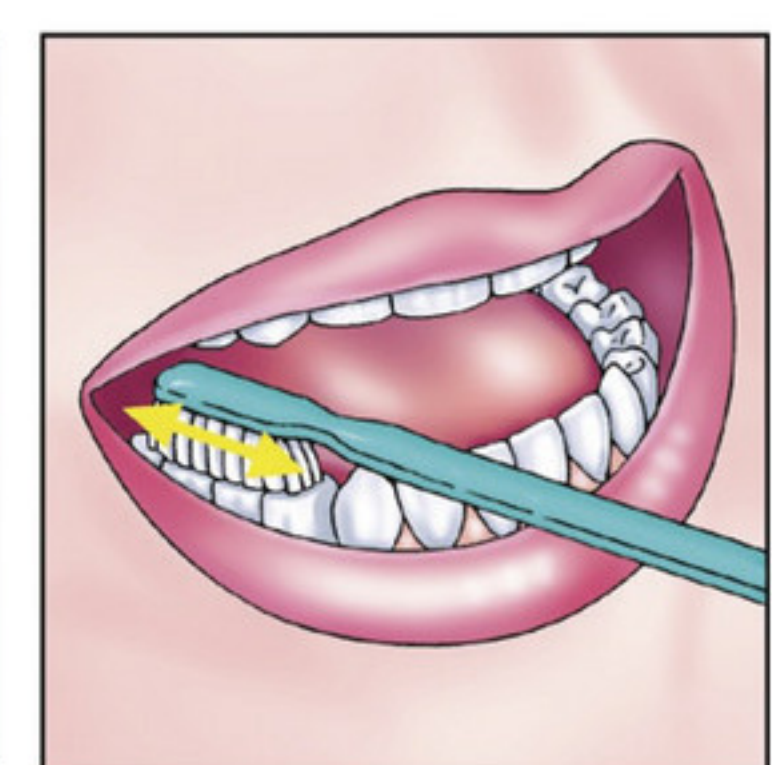
You cannot get at the spaces between your teeth using a normal toothbrush or an electric toothbrush. You should therefore use dental floss, toothpicks or interdental brushes.



inside



outside

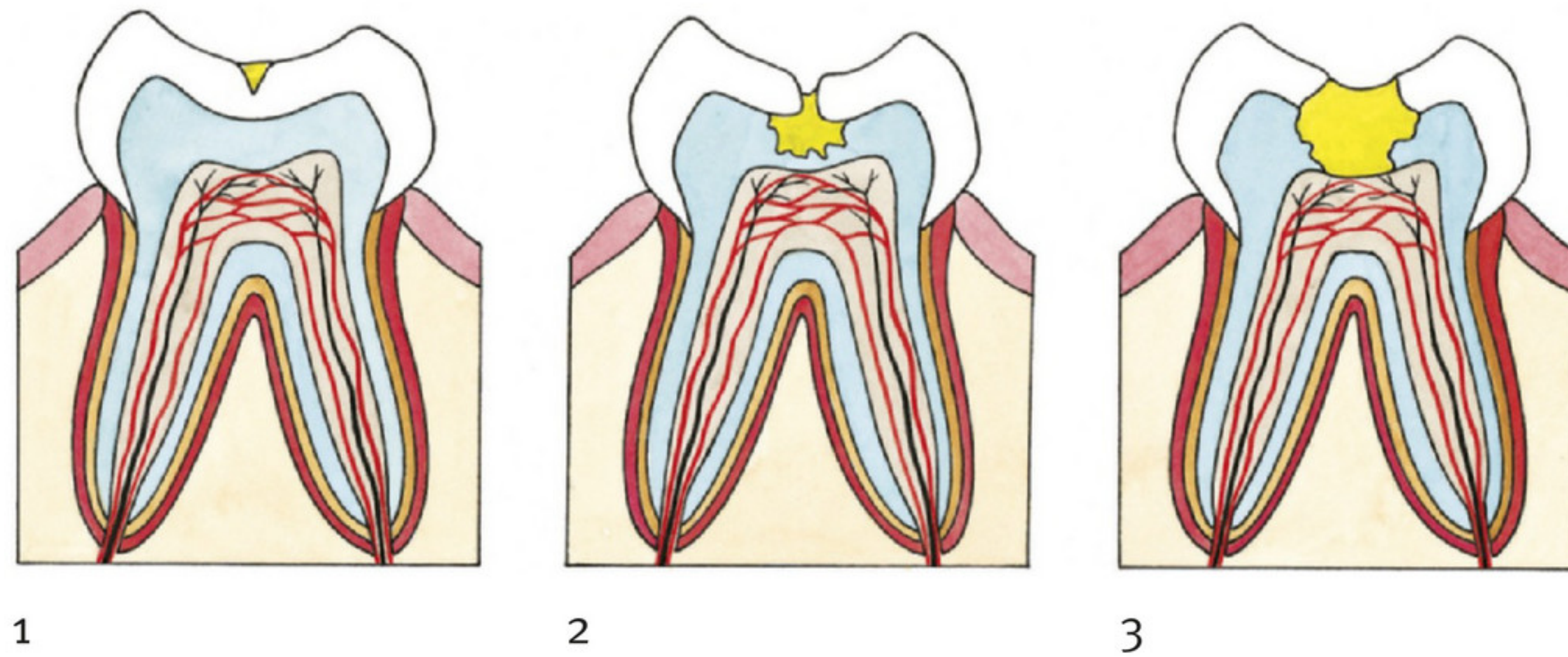


chewing surfaces

If your teeth are healthy, having something to eat six or seven times a day will not harm them. There is time for the enamel to be repaired in the meantime. If you eat something more often than that, the chance of tooth decay becomes greater. This is particularly true if your snacks contain a lot of sugar, such as sweets. The enamel does not then have time to recover and small holes may result. The dentine can then be damaged, and ultimately the whole tooth (see figure 47). If you use fluoride toothpaste, the tooth enamel is able to recover more quickly between meals or snacks (see figure 48).

► **Fig. 47** Three stages of tooth decay (schematic).

▼ **Fig. 48** Fluoride toothpastes.

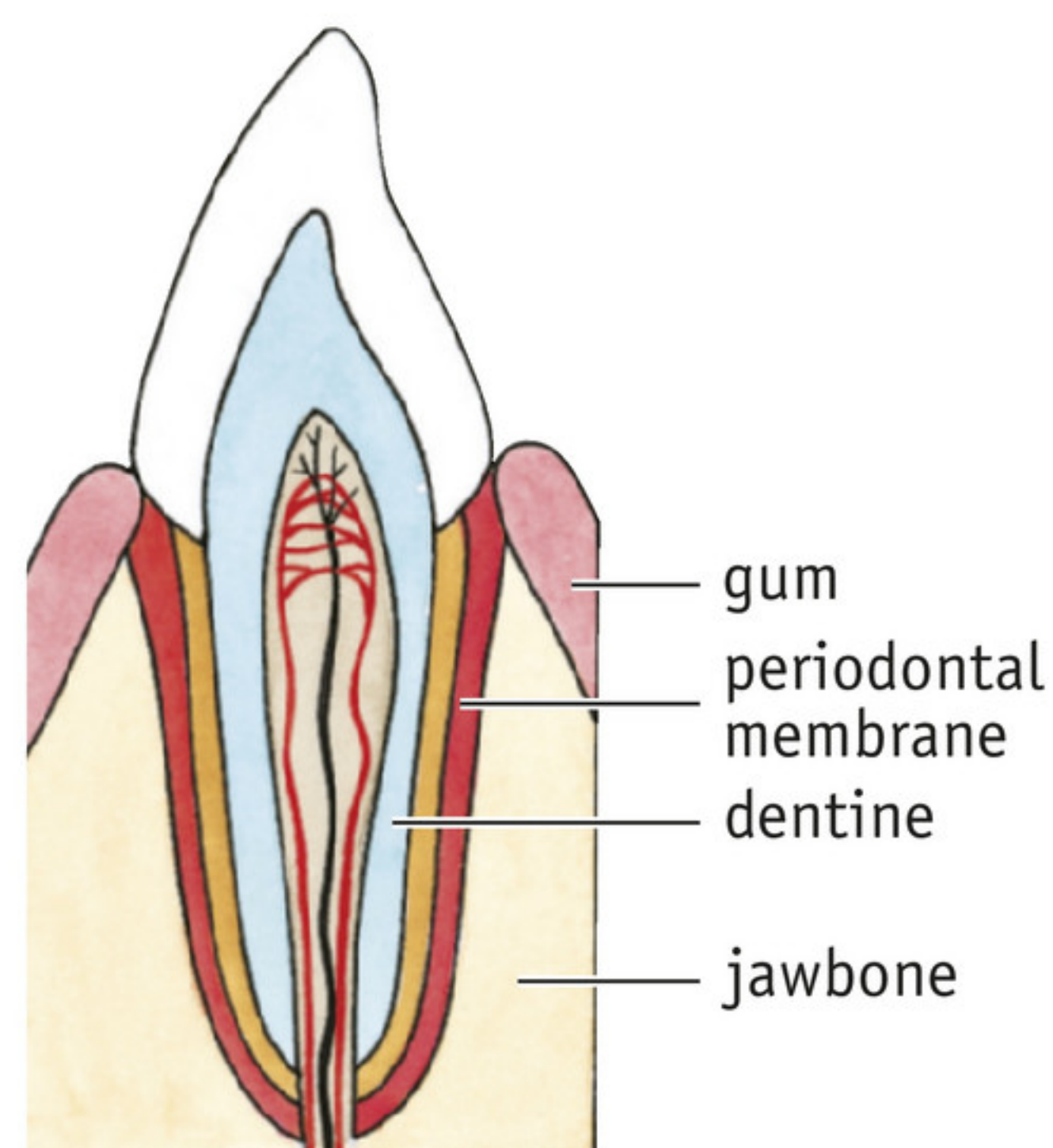


Plaque also contains bacteria that can cause **gum disease**. In gum disease the gums become inflamed. They look redder and bleed easily. Healthy gums fit tightly around the teeth (see figure 49). Inflamed gums retract and become separated from the teeth (see figure 50). This can allow plaque to get into the space between the gums and the roots. The plaque can then damage the periodontal membrane and the thin layer of cementum around the roots. If the periodontal membrane becomes inflamed, the tooth may become loose and fall out.

▼ **Fig. 49** Healthy gums.



1

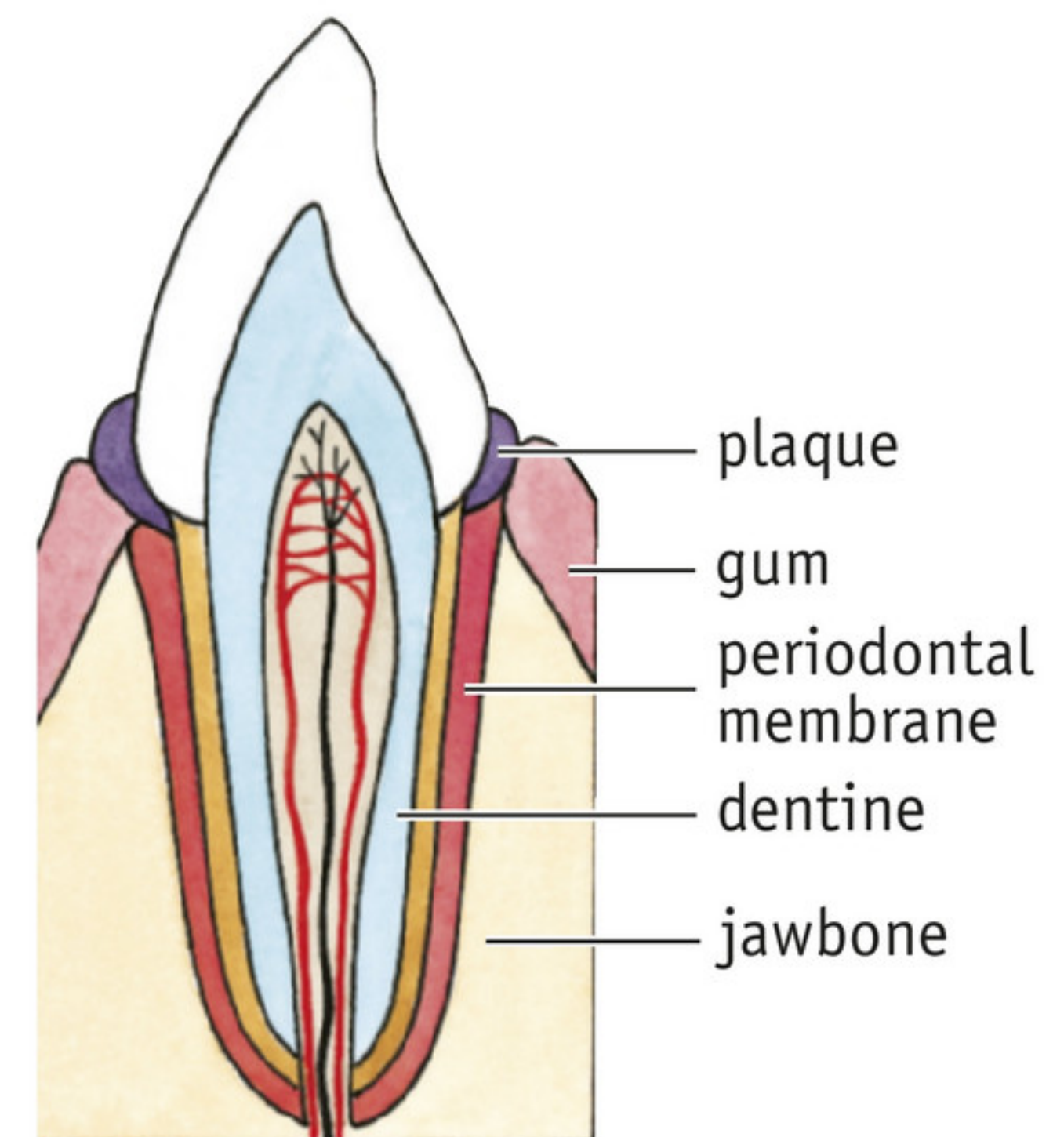


2 the gums fit tightly around the teeth (schematic)

▼ **Fig. 50** Inflamed gums.



1 receding gums



2 when the gums recede, it is easy for plaque to get into the space between the tooth and the gum

▼ Fig. 51



1 plaque disclosing tablets



2 the red areas are where plaque is present

Plaque disclosing tablets contain a dye that lets you check for yourself where the plaque is on your teeth. If the dye still shows a stain after brushing, then there is plaque there (see figure 51).

Plaque that stays stuck in place will harden and change into **tartar**. Tartar is so hard that you can no longer brush it away. That has to be done by a dentist (or dental hygienist). This is why it is important to go to the dentist for a checkup every six months.

If any teeth are damaged, the dentist will drill out the damaged part and fill it (see figure 52). If the teeth are not positioned correctly, they can be realigned using **orthodontic correction** (see figure 53).

WB EXERCISES 34 TO 36, PAGE 67

▼ Fig. 52 Teeth with fillings.



tooth with filling

▼ Fig. 53 Orthodontic correction using a fixed brace.

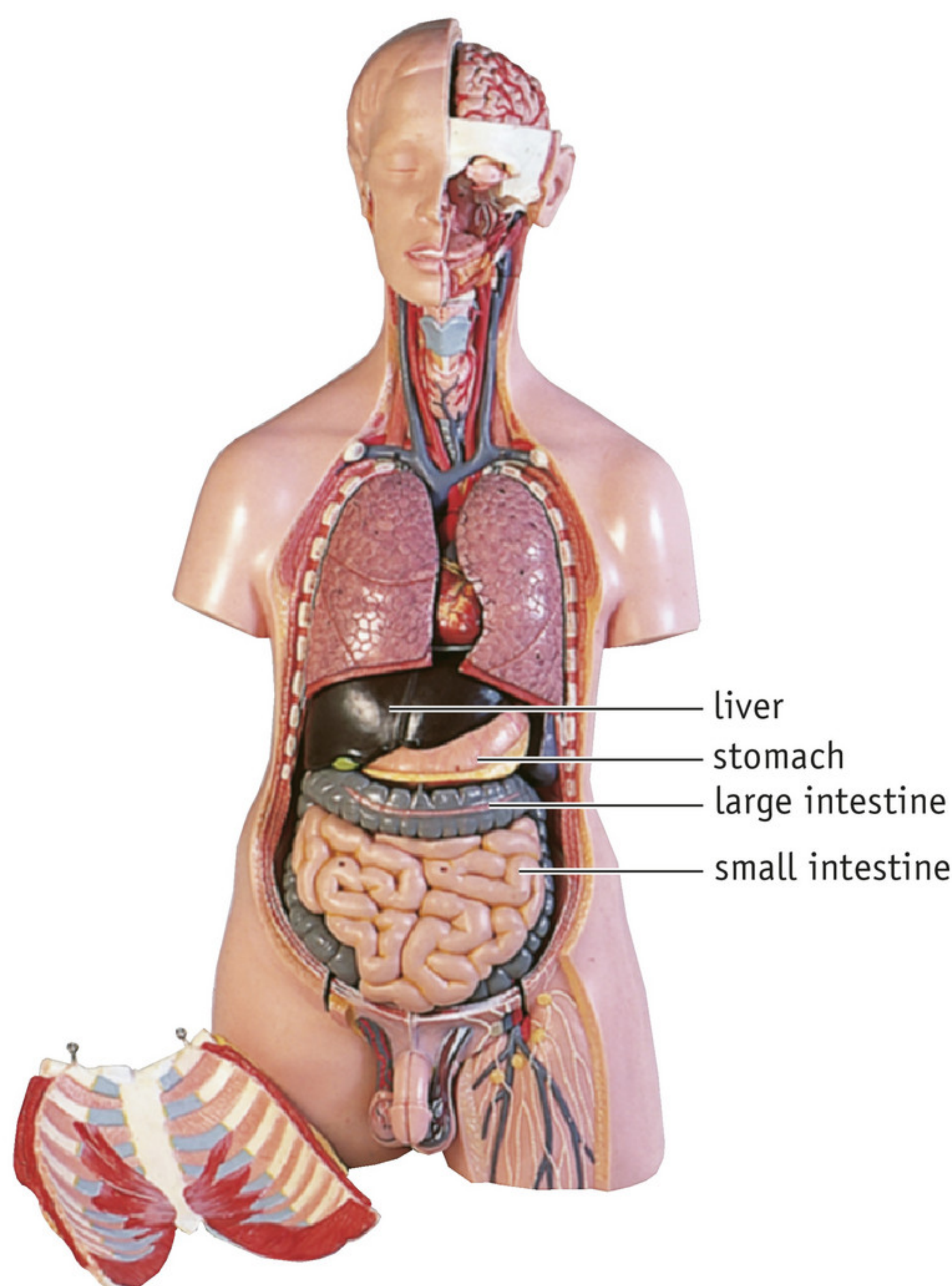


8 The digestive organs

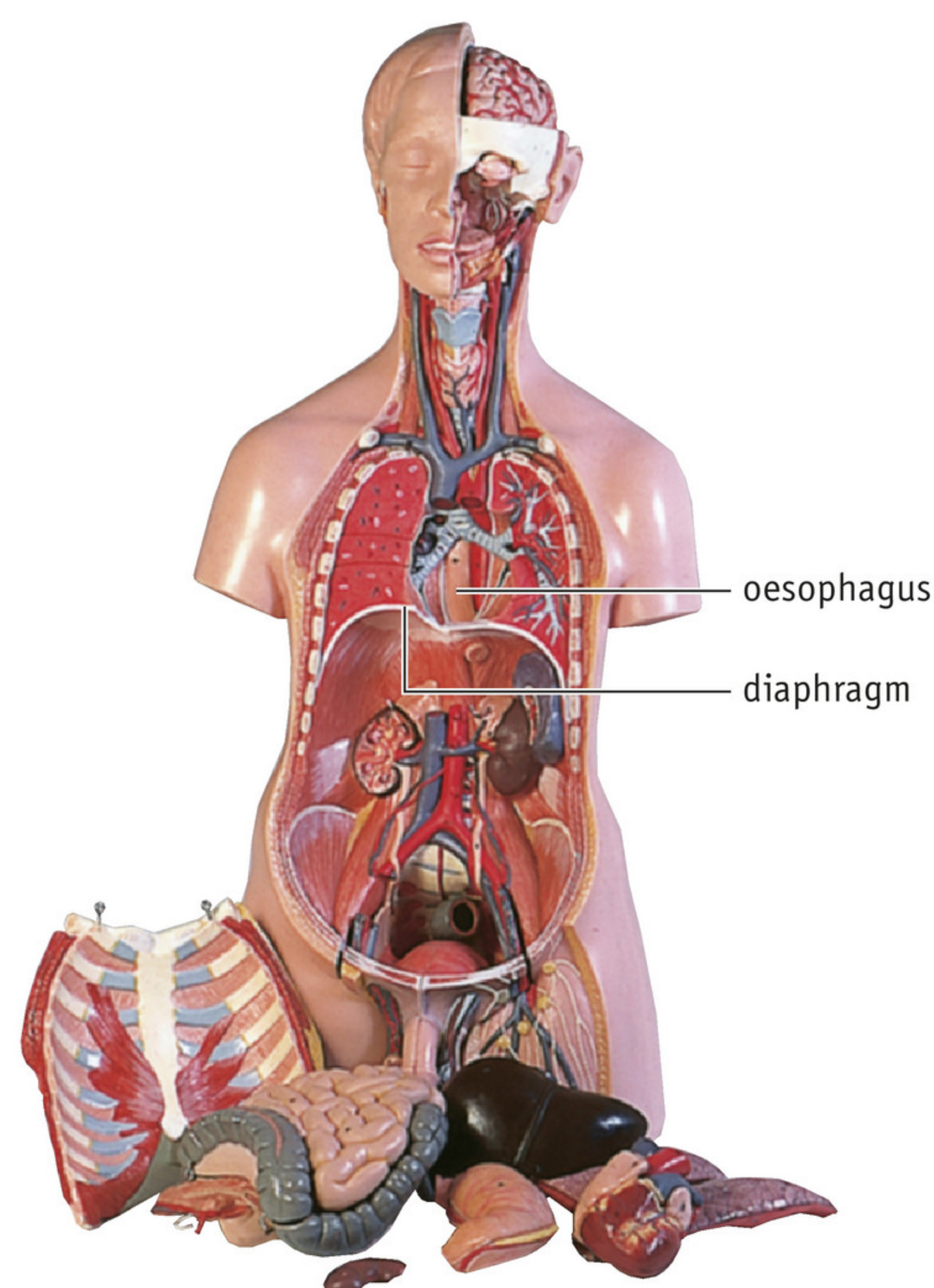
The organs of the digestive system are mostly in the abdomen. Figure 54 shows photos of the torso of a man, showing the internal organs, including the ones that play a role in digestion.

WB EXERCISE 37, PAGE 71

▼ Fig. 54 The torso of a man (with head).

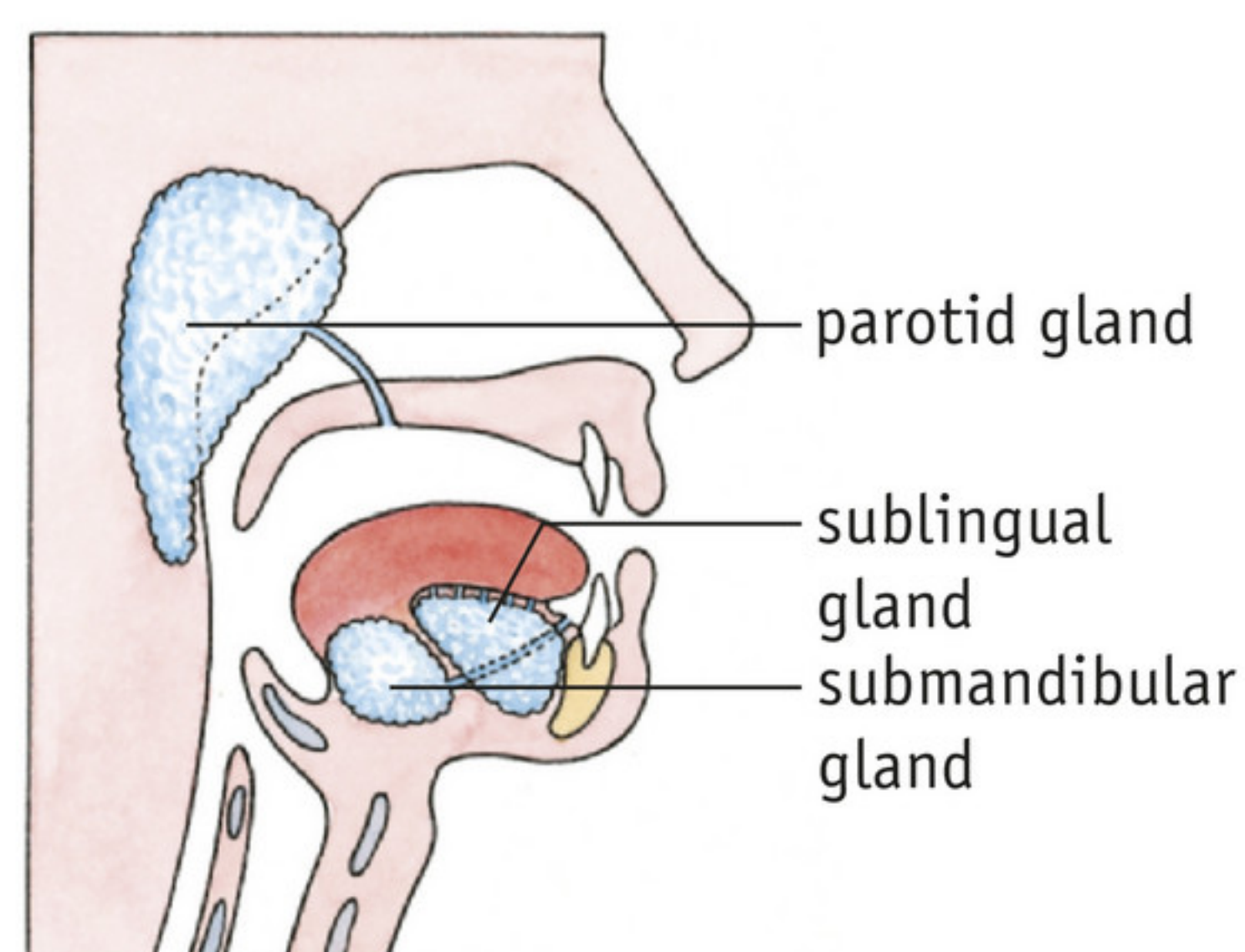


1 the ribs and breastbone have been removed from the torso



2 a number of organs have been removed from the torso

▼ Fig. 55 The position of the salivary glands (schematic).

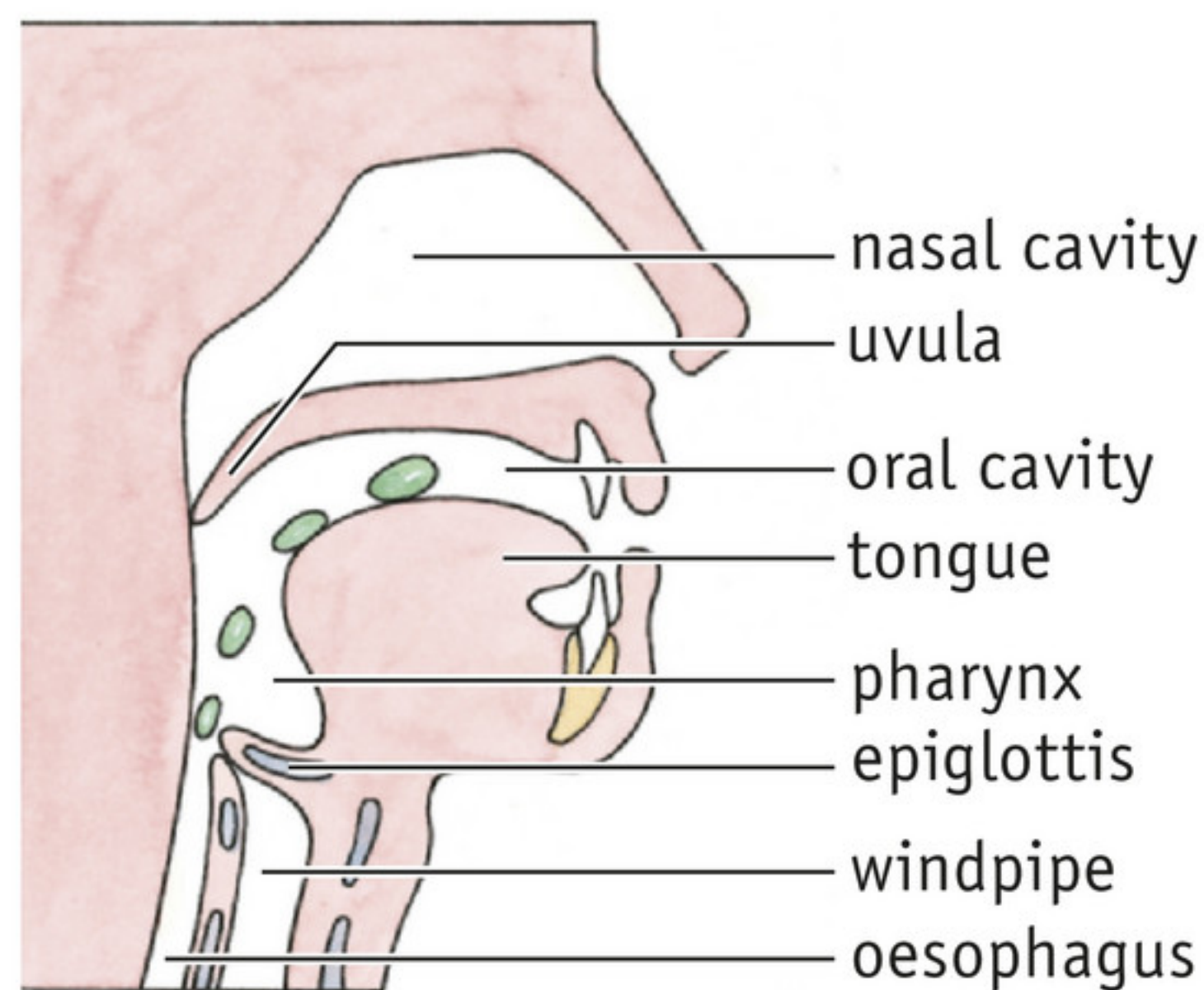


ORAL CAVITY, PHARYNX AND OESOPHAGUS

The digestion of food starts in your **oral cavity**. When you chew, your food is broken up into small pieces so that you are able to swallow it. In basics 7, you learned that chewing also increases the surface area of the food.

Your **salivary glands** (see figure 55) produce **saliva**, which consists of water, mucus and an enzyme. The mucus makes the food more slippery, so that swallowing it is easier. The **enzyme** in saliva breaks down starch. This means that some of the **starch** in your food is already being digested in your mouth.

▼ Fig. 56 Swallowing food (schematic).



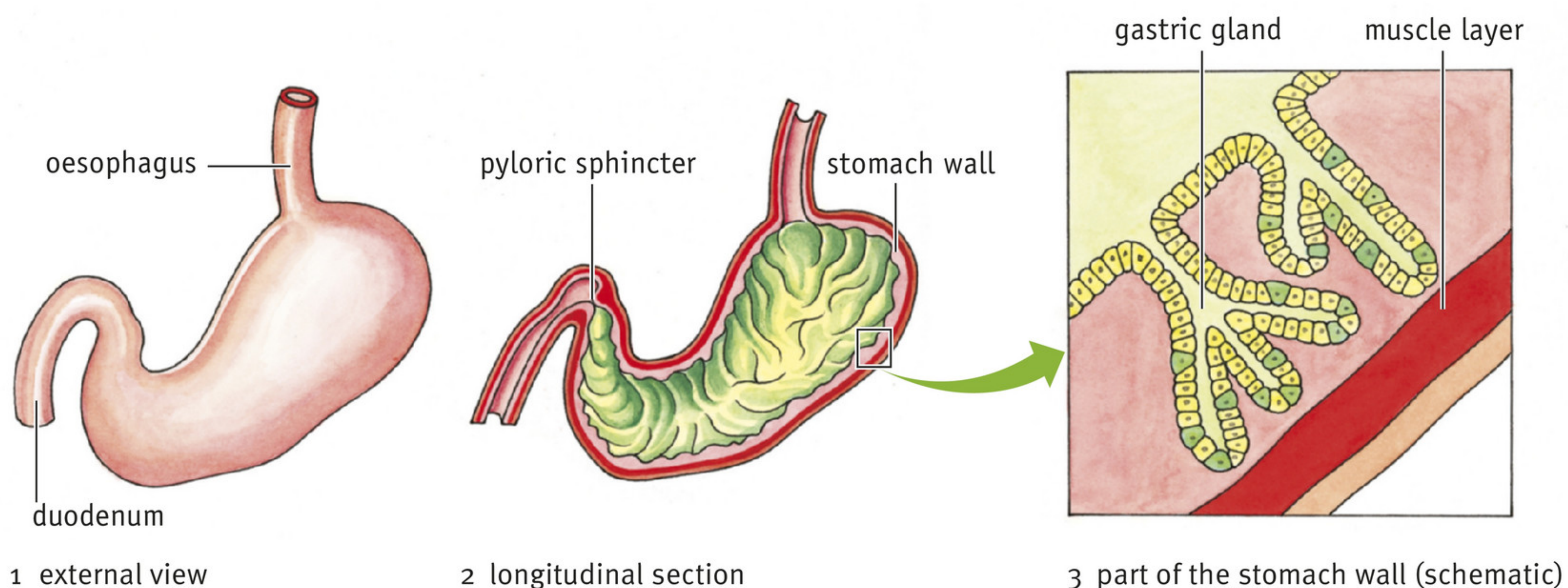
You then use your tongue to push the food from the oral cavity towards the **pharynx**. Swallowing your food pushes it into the **oesophagus (gullet)**. When you swallow, the nasal cavity is automatically closed off by the uvula and the windpipe is closed off by the epiglottis (see figure 56). The food is then only able to go down the gullet.

Peristalsis pushes the food along the oesophagus into your stomach. No digestive juices are added to the food in the oesophagus.

STOMACH

Because the circular muscles and the longitudinal muscles in the stomach wall contract and relax alternately, your **stomach** is almost constantly moving. At the end of your stomach, there is a circular muscle that can close off the exit from it. This is the **pyloric sphincter** (see figure 57). Each time it opens, this muscle lets just a small amount of food through to the duodenum. This means that the stomach also has a role as **temporary storage area** for food.

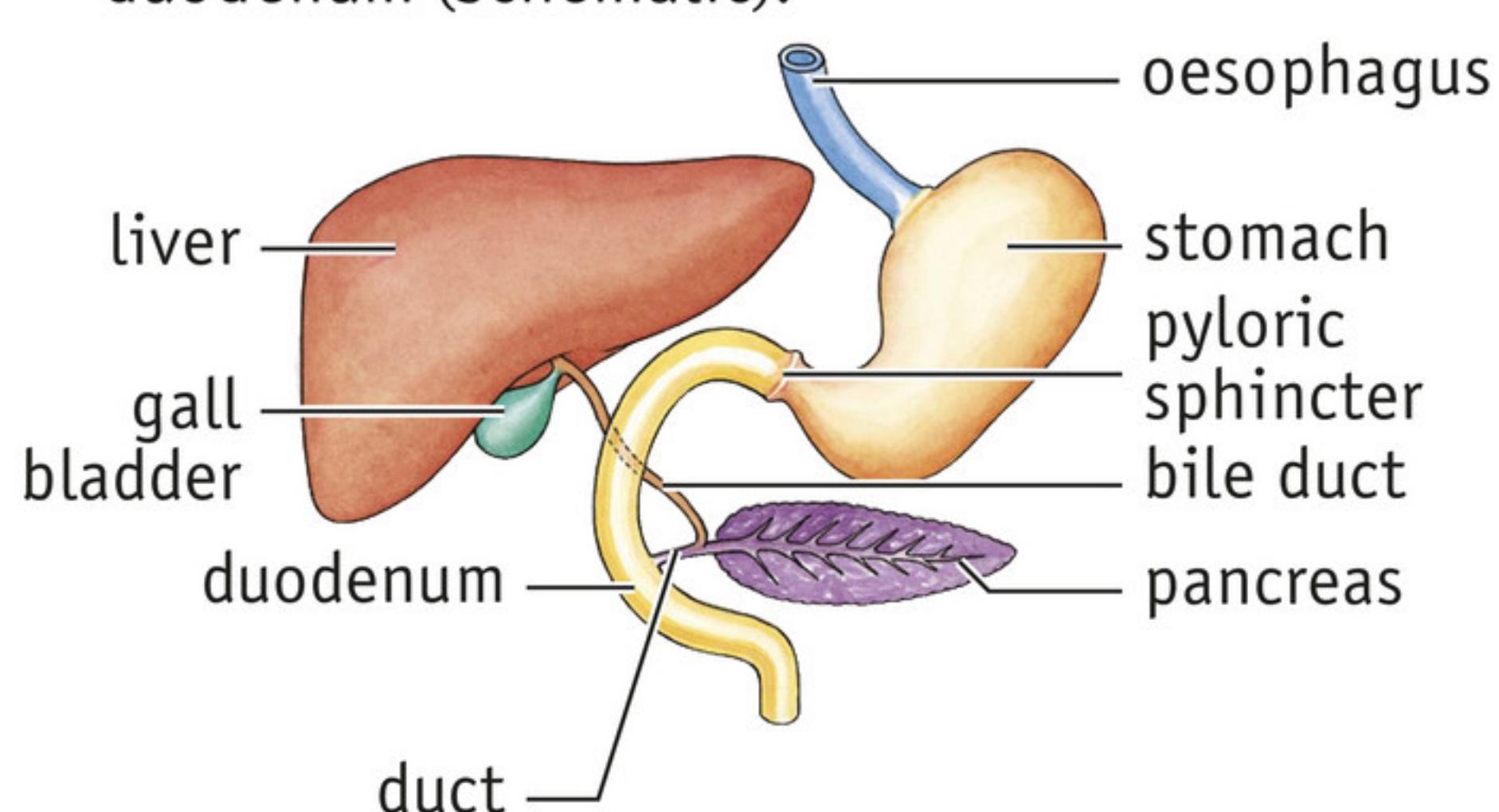
▼ Fig. 57 The stomach.



Gastric glands (see figure 57.3) in the wall of the stomach produce **gastric juices**. The continuous movement of the stomach wall kneads the food in the stomach and mixes it with the gastric juices. Gastric juice consists of **water**, **hydrochloric acid** and an **enzyme**. The hydrochloric acid makes sure that any bacteria in your food are killed. The enzyme in the gastric juice partially digests the **proteins** in your food.

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▼ Fig. 58 The location of the stomach, liver, gall bladder, pancreas and duodenum (schematic).



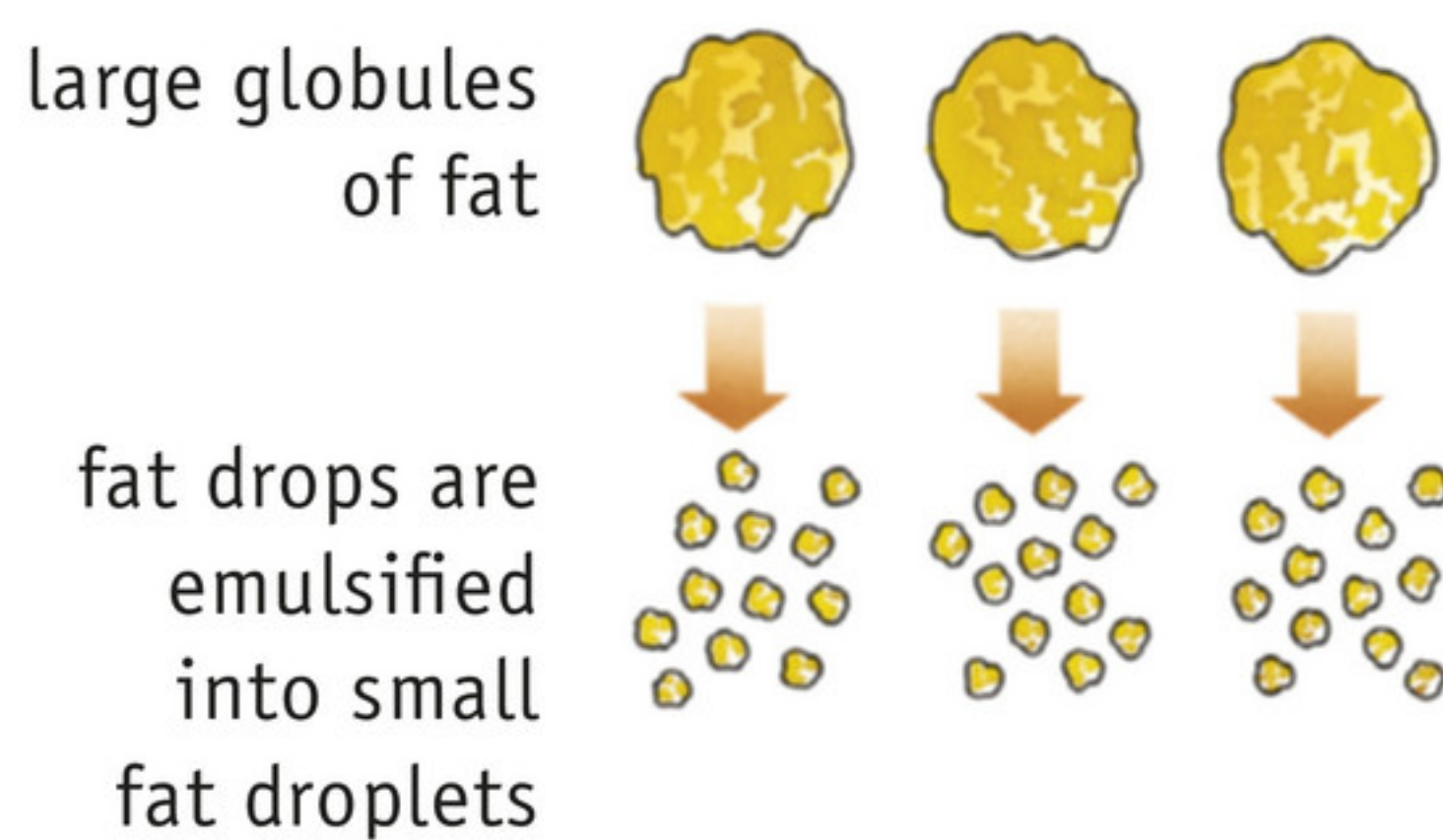
DUODENUM, LIVER, GALL BLADDER AND PANCREAS

Ducts leading from the liver and pancreas end in the **duodenum** (see figure 58). The **liver** produces **bile**, which is stored temporarily in the **gall bladder**. Bile is passed from there to the duodenum through the **bile duct** when it is needed. The gall bladder is therefore not a gland: it is just a storage place.

▼ **Fig. 59** Water with drops of fat.



▼ **Fig. 60** Bile emulsifies fats.



Fats do not mix with water, but create large drops instead (see figure 59). Bile **emulsifies** fats (see figure 60). That means that the bile breaks the large fat globules up into small fat droplets. The bile itself does not digest the fats. Emulsification increases the surface area of the fat droplets a great deal, making it easier for the enzymes to access the fats and thereby letting them digest the fats faster.

The **pancreas** produces **pancreatic juices**, which contain various enzymes that assist in digesting **proteins**, **carbohydrates** and **fats**.

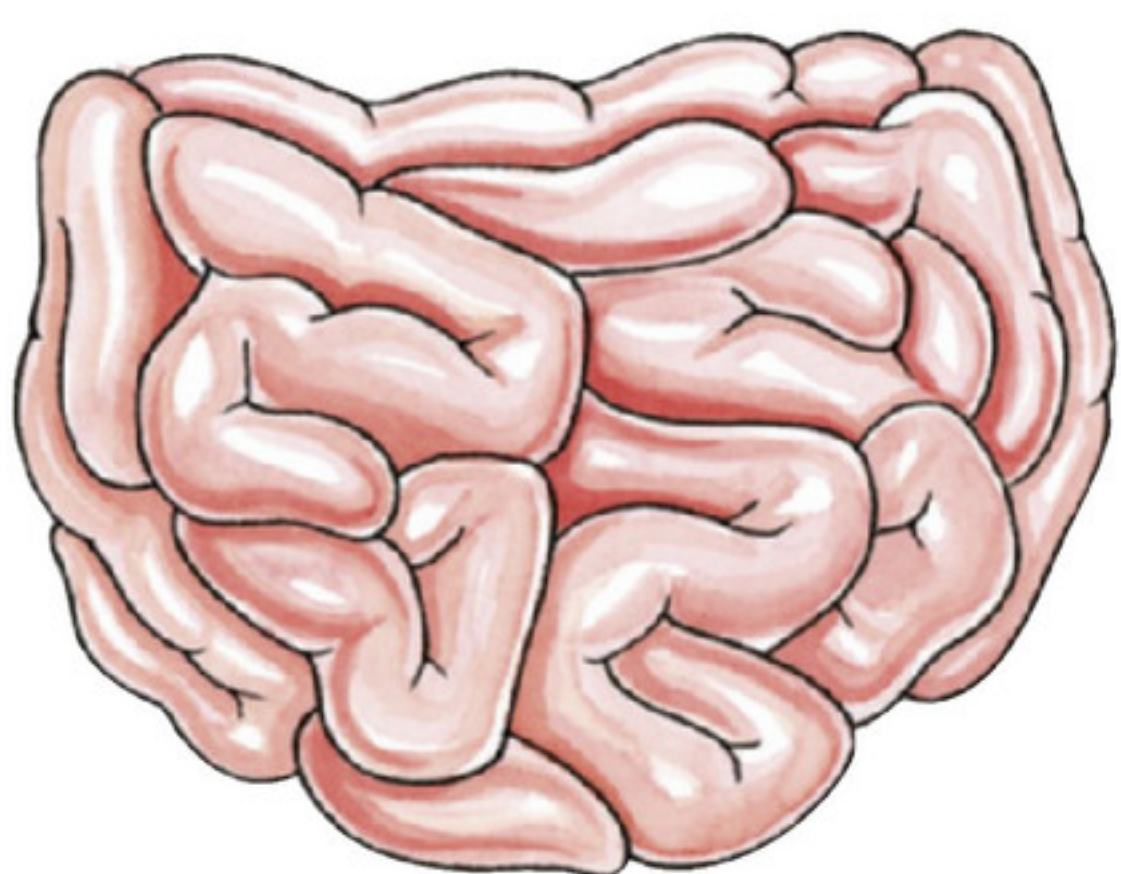
SMALL INTESTINE

In humans, the **small intestine** is about 8 metres in length. The wall contains **intestinal glands** that secrete **intestinal juice**. Intestinal juice contains various enzymes that complete the digestion of **proteins**, **carbohydrates** and **fats**. The digested substances can then be absorbed into the blood.

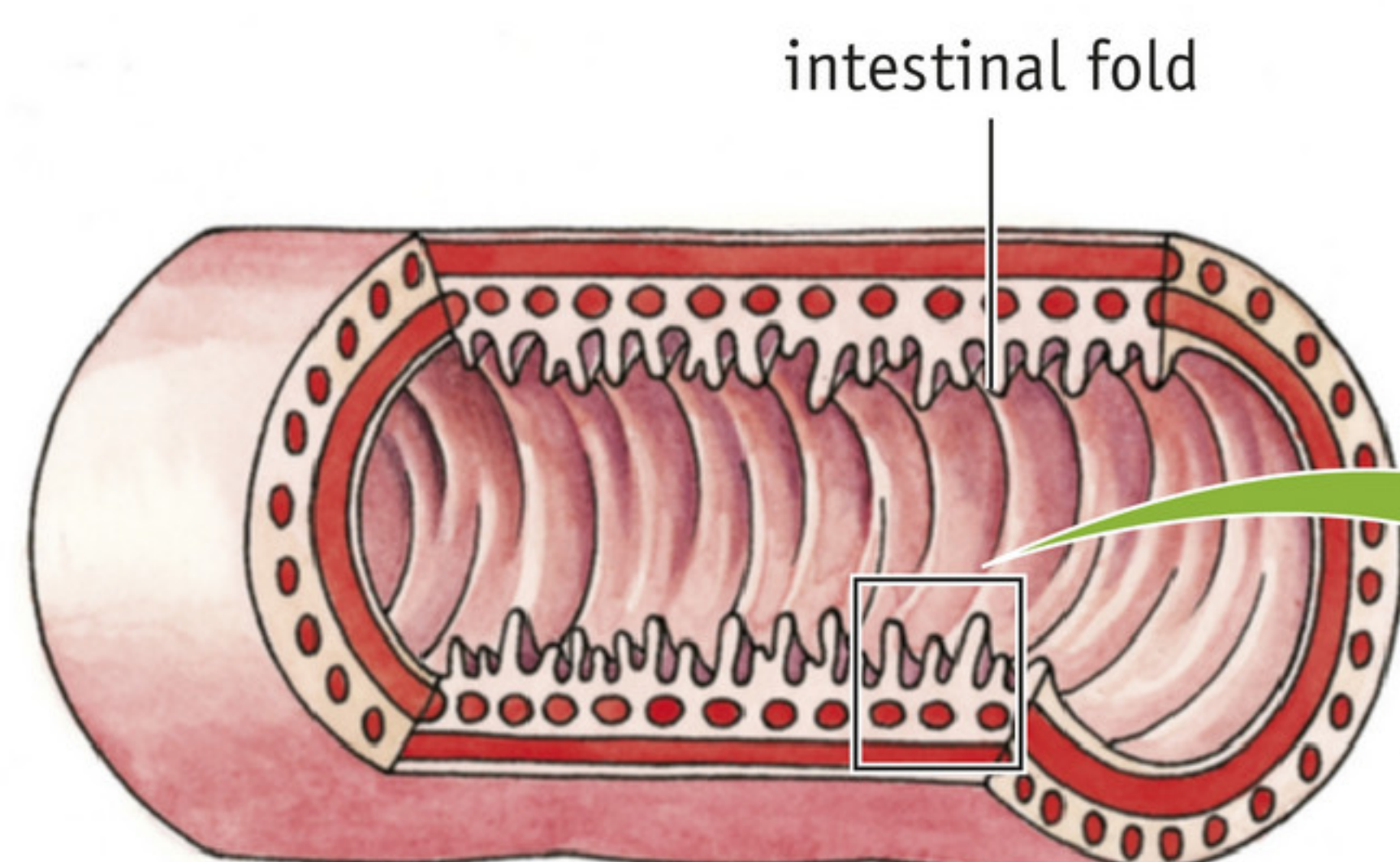
In the gut, various digestive juices are added to the food pulp. Because all the digestive juices contain a lot of water, the food pulp now also contains a lot of water. Nutrients and digestion products are dissolved in the water. The bulk of the water containing the nutrients and digestive products is absorbed into the blood in the small intestine.

The wall of the small intestine is very convoluted – it has lots of folds (see figure 61). The **intestinal folds** in turn have protrusions called **intestinal villi**. There are **blood vessels** in the intestinal villi. The walls of the intestinal villi are very thin. This means that water containing dissolved nutrients and digestion products can pass through the intestinal wall and be absorbed into the blood in the capillaries. The intestinal folds and the intestinal villi give the small intestine a large surface area, so that these substances can be absorbed quickly. The blood transports the absorbed substances to the body's cells. You will learn more about that in unit 3 (The circulatory system).

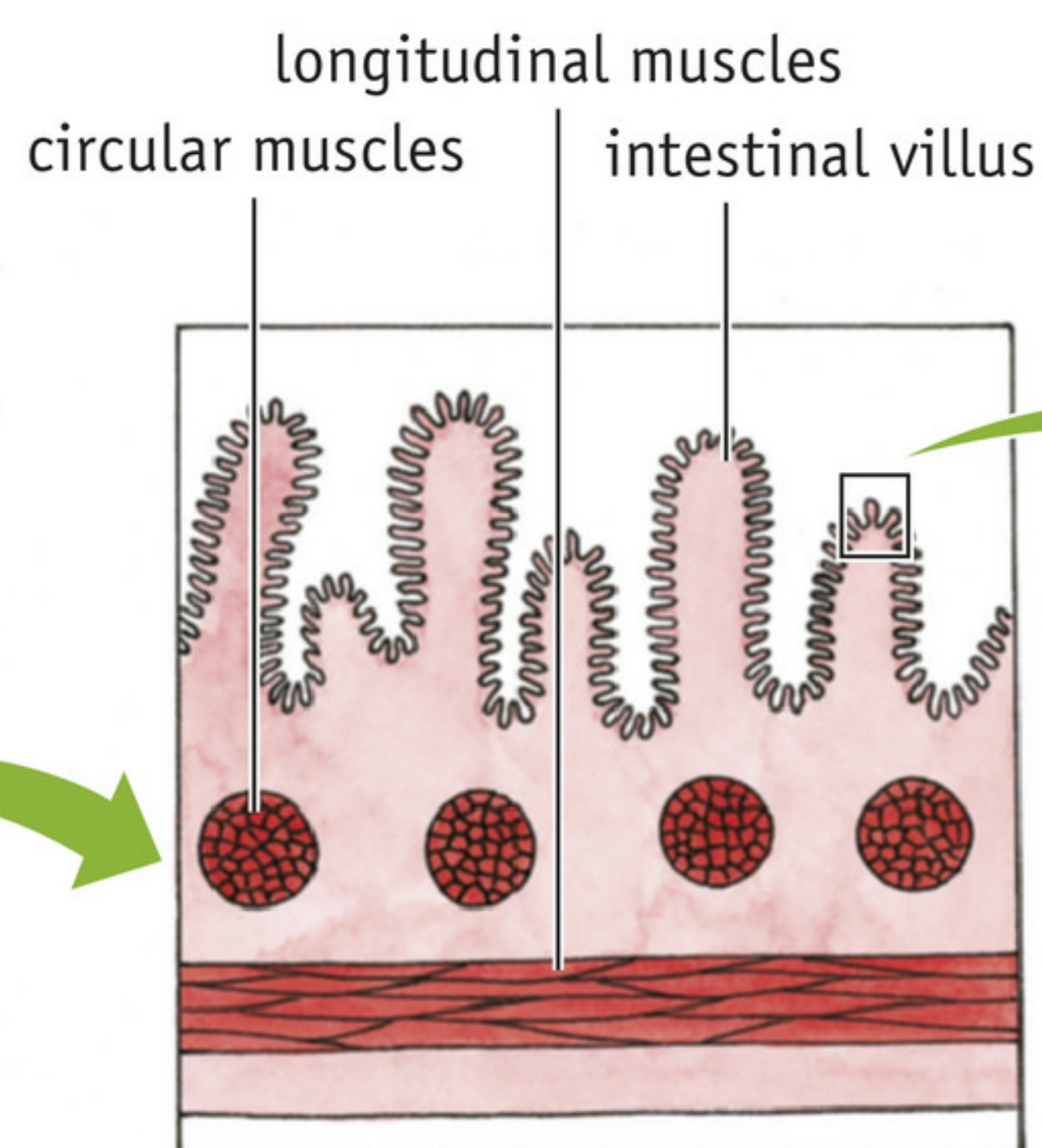
▼ **Fig. 61** The structure of the small intestine (schematic).



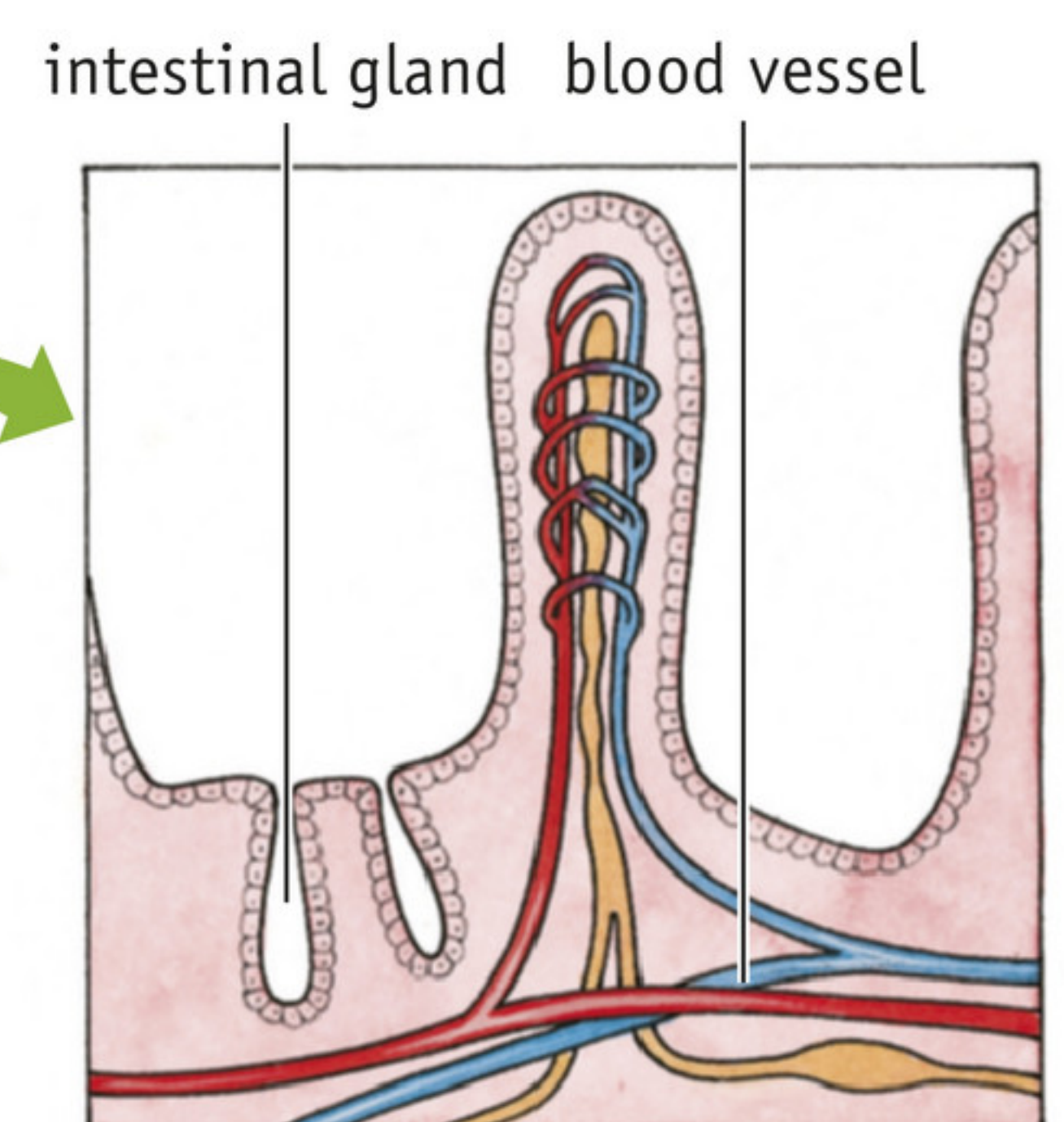
1 small intestine (external view)



2 part of the small intestine (cross-section)



3 intestinal folds, magnified

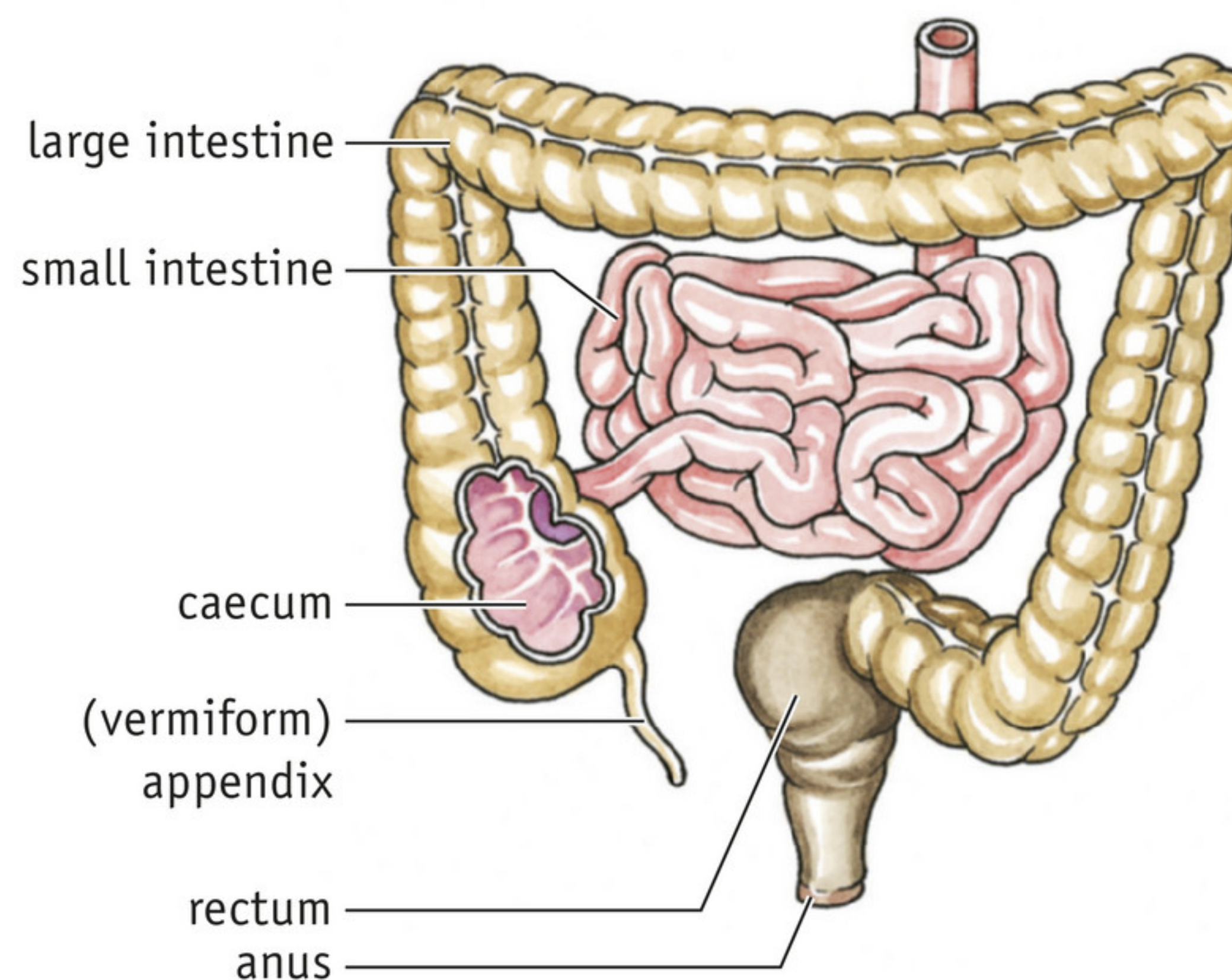


4 intestinal villus, magnified

APPENDIX, LARGE INTESTINE AND RECTUM

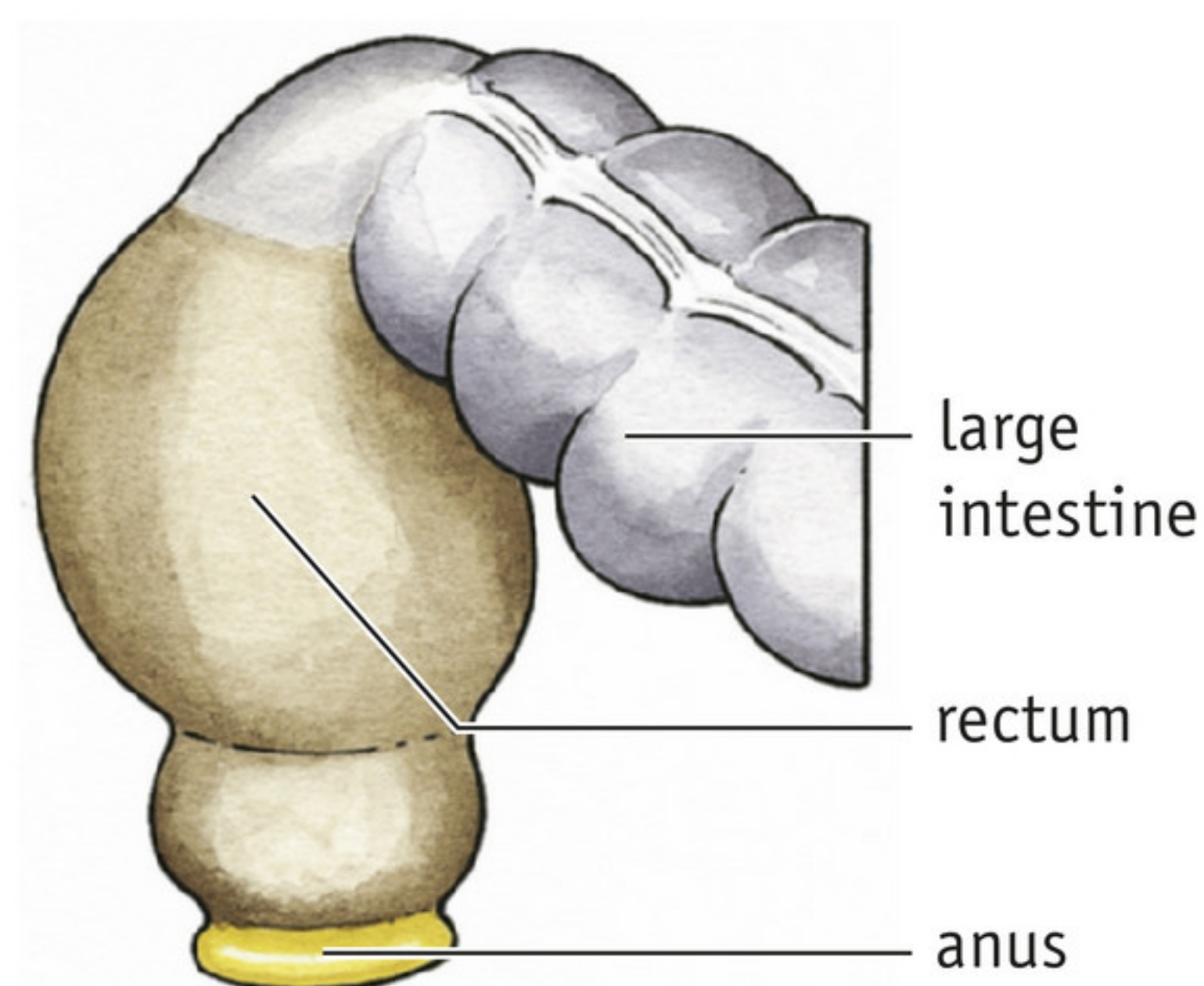
Just below the point where the small intestine exits into the large intestine, there is the **caecum** (see figure 62). At the bottom of the caecum is a small protrusion called the **appendix** (or **vermiform appendix** in full). This is the part that is inflamed in appendicitis. It may then be surgically removed, but the caecum is left in place.

▼ **Fig. 62** The location of the small intestine, caecum with vermiform appendix, large intestine and rectum with anus (diagram).



The **large intestine** is about 1.5 metres long. Undigested food residues are passed from the small intestine into the large intestine. This pulp of undigested food residues still contains a lot of water. In the large intestine, almost all the water is extracted from the food residues and absorbed into the blood that is in the capillaries of the large intestine. This makes the mass of undigested food thicker. If that did not happen, you would lose too much water and become dehydrated. Indeed, when you have **diarrhoea**, not enough water is being absorbed into the blood from the small intestine and large intestine.

▼ **Fig. 63** The rectum and the anus.



The cell walls of foodstuffs obtained from plants contain **cellulose**. This is difficult for humans to digest because their digestive juices do not contain an enzyme that is capable of breaking cellulose down. However, numerous bacteria live in the large intestine that produce an enzyme for digesting cellulose. This means that some of these plant food residues are digested in the large intestine after all. Digestion of cellulose produces glucose, among other things. Part of that glucose is absorbed into the blood from the large intestine.

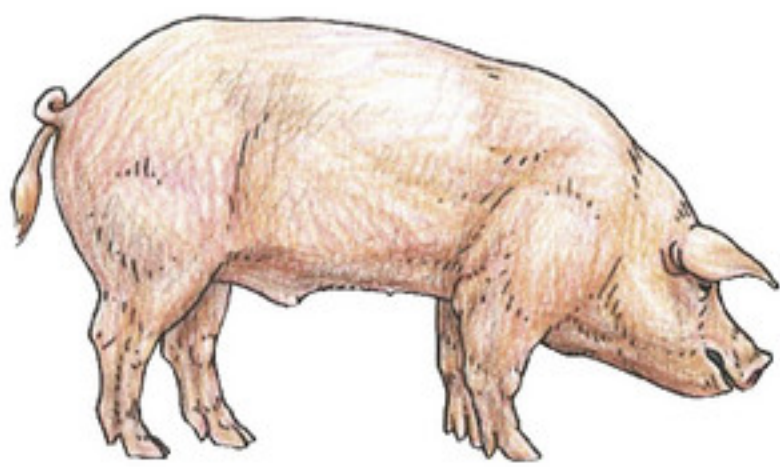
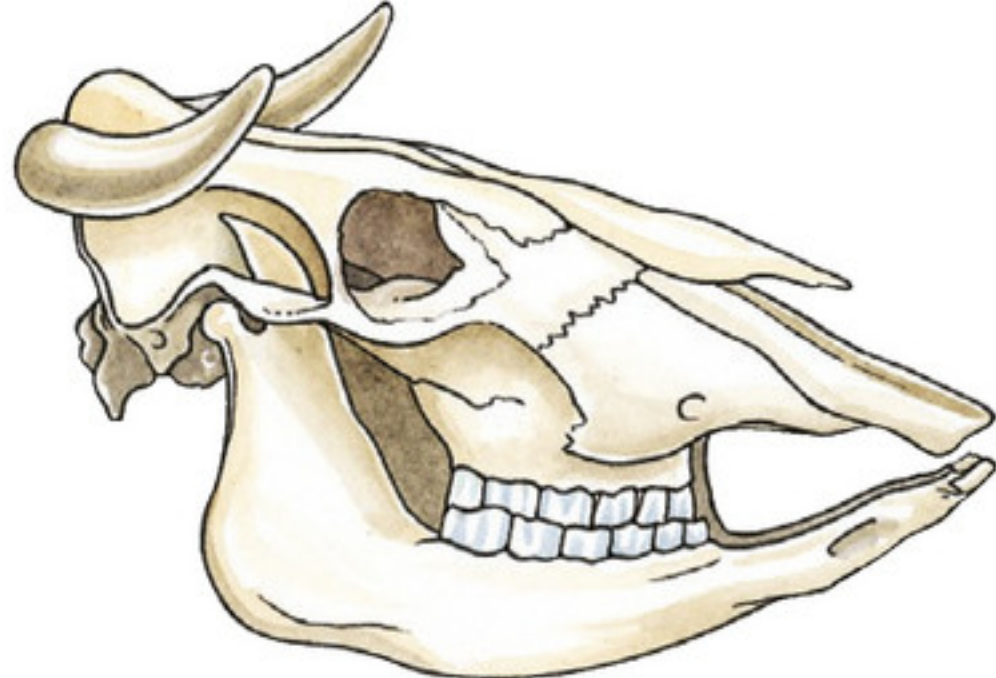
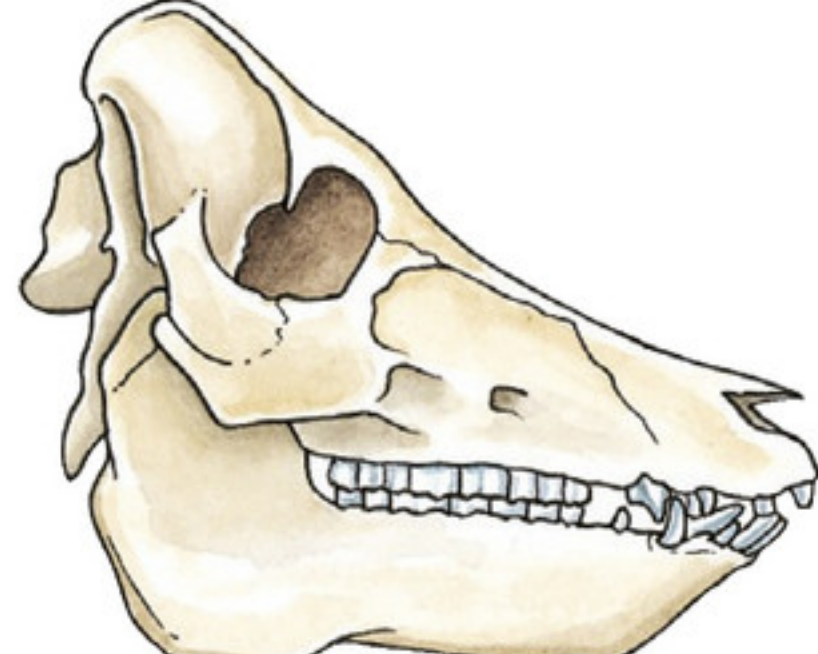
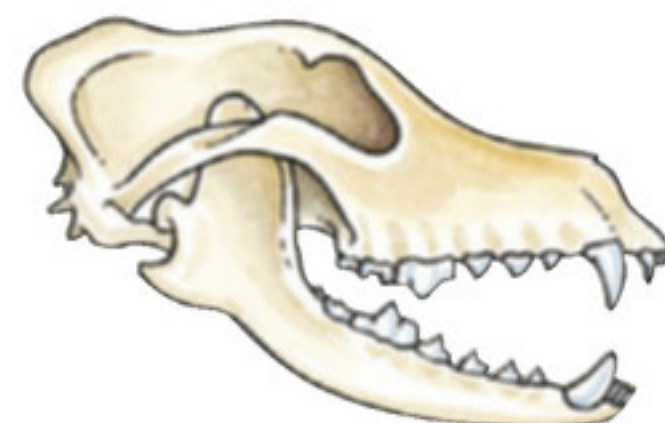
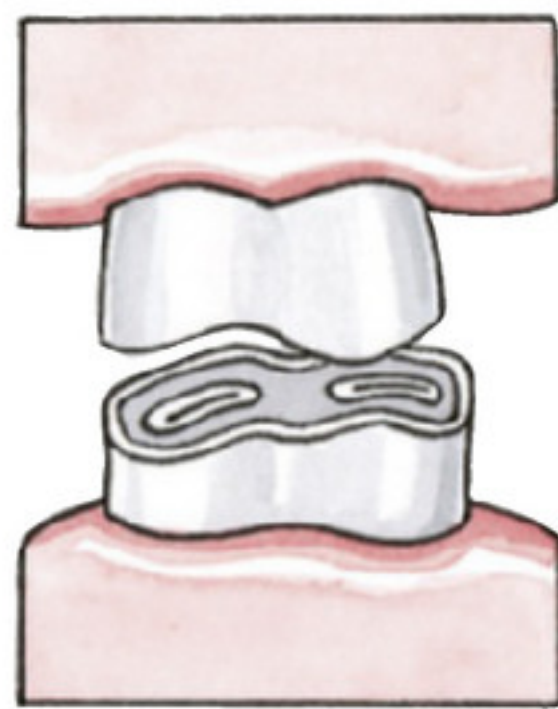
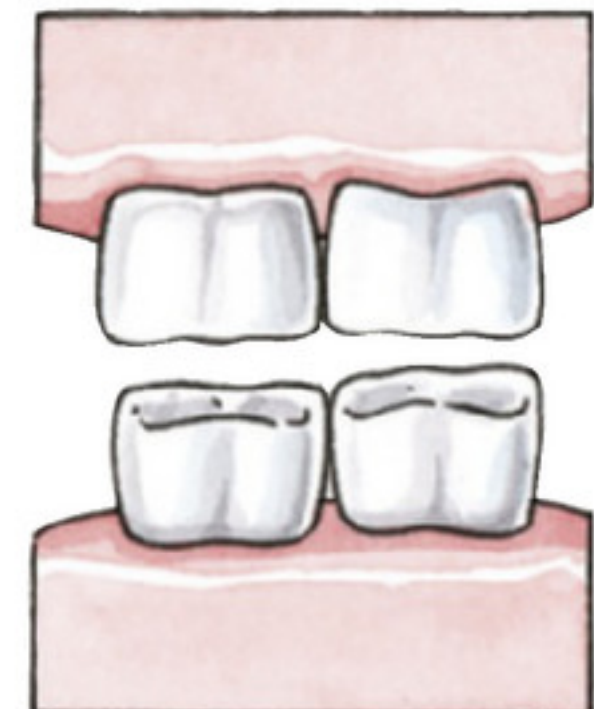
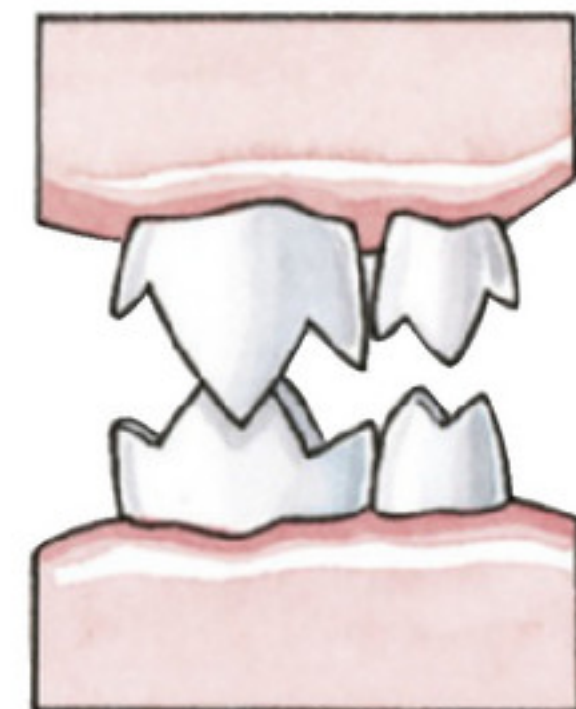
Peristalsis moves the thickened, undigested food residues to the **rectum** (see figure 63), where they are collected and stored. The intestinal tract is closed off by a circular muscle or sphincter, the **anus**. From time to time, this sphincter can be relaxed and the rectum is emptied. This elimination of faeces is called a **bowel movement**.

9 Nutrition and digestion in mammals

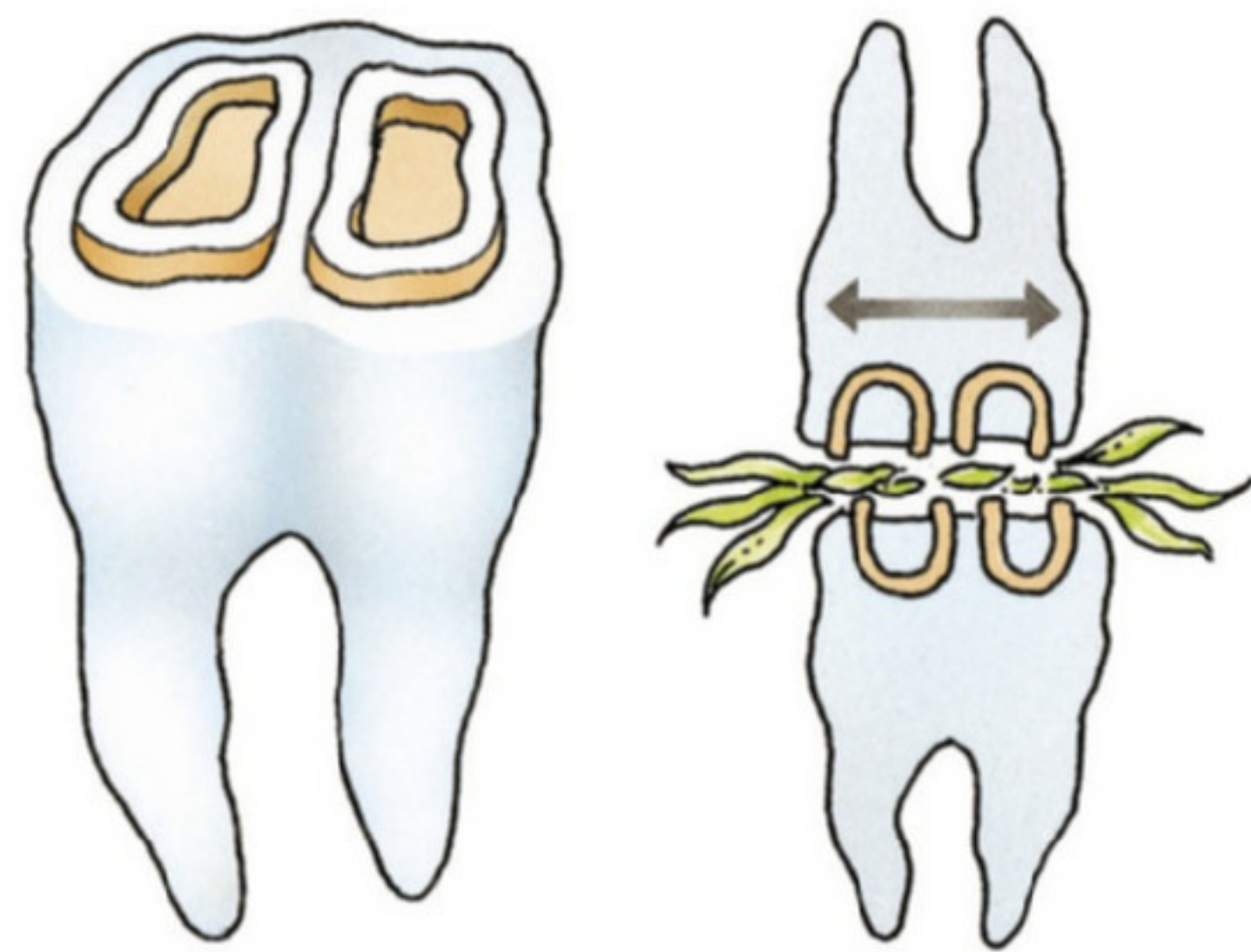
Mammals can get their food in various ways. Animals that only eat plants are called **herbivores**. Ones that only eat other animals are called **carnivores** and mammals that eat both plants and animals are called **omnivores**. There are differences between the digestive systems of herbivores, carnivores and omnivores.

Vegetable matter is more difficult to digest. This is because plant cells have **cell walls**. The cell walls include the component **cellulose**. You learned in basics 8 that this substance is difficult to digest. Because there are no cell walls in animal foodstuffs, these are easier to digest.

▼ **Fig. 64** Features of the body structure of herbivores, carnivores and omnivores.

	Herbivore	Omnivore	Carnivore
1 Length of the intestinal tract, in relation to body length	 long	 medium	 short
2 Skull			
3 Molars	 ridged	 knobbly	 pointed

▼ **Fig. 65** The food is ground up finely between the hard ridges of the molars.



HERBIVORES

Plant eaters are called **herbivores**. They have a relatively long intestinal tract, compared to their body length. The intestines of a cow, for example, are 40 metres long. That is about 25× as long as the body. As a result, the animal's girth is relatively large in comparison with its body length (see figure 64.1). Herbivores have **ridged molars** (see figure 64.3). These are molars with tough ribs of enamel. As the animal chews, the food is crushed fine between the ridges (see figure 65). The ridges are perpendicular to the direction of the chewing motion. Herbivores often lack canines (see figure 64.2).

CARNIVORES

Meat eaters are called **carnivores**. They have a relatively short intestinal tract, compared to their body length. In a dog, for example, the intestinal tract is about 5.5× as long as the body. The body can therefore have a slender shape (see figure 64.1).

Carnivores have **pointed molars** (see figure 64.3). These are sharp teeth that can cut the food into pieces so that it can be swallowed quickly. The upper jaw is wider than the lower jaw, so that the molars slide past each other, shearing like a pair of scissors (see figure 66).

The canines are mostly large, pointed and sharp (see figure 64.2). They are used for killing the prey and tearing off chunks of meat. They can also be used for defence.

► **Fig. 66** The upper jaws of carnivores are wider than the lower jaws.



1 front view of the skull



2 side view of the skull

OMNIVORES

Animals that eat everything are called **omnivores**. The intestinal tract in omnivores is medium length in comparison to the body length.

Omnivores have molars that have a **knobbly** surface (see figure 64.3). The molars have a surface that allows the food to be ground up.

Omnivores generally do have canines. In some omnivores, they are large, pointed and sharp (see figure 67). They are then used for killing prey. In other omnivores, the canines are much the same size as the incisors (see figure 64.2).

Humans are also omnivores and we have molars with a knobbly surface. We cut our food up smaller with knives and process it by boiling, roasting and so on. This helps us digest parts of our vegetable foods.

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► **Fig. 67** Omnivore (wild boar).



10 How do you stop food from spoiling?

You learned in part 1 that bacteria and fungi in nature clear up the remains of dead organisms. Our food also consists of (dead) residues of organisms, such as meat, vegetables and fruit. Because bacteria and fungi are able to live off this perfectly well, the food can 'go off'.

Fish and meat spoiling (chicken in particular) is often caused by **salmonella bacteria**. These bacteria may be present in the food in small numbers (see figure 68). They produce waste products that are toxic. Salmonella bacteria can multiply very quickly, particularly at temperatures of between 20 and 30°C. It is dangerous to eat food that has been contaminated with salmonella bacteria. It can make you very sick. This is often called **food poisoning**.

▼ Fig. 68

Salmonella poisoning from salmon

In 2012, thousands of people became ill after eating smoked salmon. The smoked salmon had become infected with salmonella bacteria during the packaging process. Dishes that the smoked salmon was left on were made of a porous material. The bacteria were able to nestle in the pores. Contamination with this bacterium can upset your intestinal tract quite severely. Small children, pregnant women, the elderly and people whose resistance is low are the ones who are most at risk. Without medical help, patients can die of the illness. Victims suffer abdominal pain, vomiting, diarrhoea or fever. The Netherlands Food and Consumer Product Safety Authority (NVWA) monitors the measures taken by manufacturers. Salmonella occurs widely in

animals, particularly poultry and pigs. The bacterium lives mostly in the intestinal tracts of these animals, but may get anywhere via the faeces.



PRESERVING FOOD

Foods can be treated so that they do not spoil. This is called **preserving** it. Preserving food makes the conditions unfavourable for bacteria and fungi. Many bacteria and fungi then die. Most bacteria and fungi cannot survive at low or high temperatures. Methods of preserving can include freezing, pasteurisation, sterilisation and drying. Preservatives may also be added. Figure 69 shows you various preservation methods.

▼ Fig. 69 Ways of preserving food.

PRESERVING FOOD**1 Freezing**

Cooling food to temperatures of -20°C or less lets you keep food in a deep freeze for several



weeks or even months. The temperature is too low for bacteria and fungi to be able to reproduce. Once the food is defrosted, the bacteria and fungi can reproduce quickly again. Food from the freezer should therefore be prepared quickly once it has been thawed.

2 Pasteurisation

Heating milk briefly to 72°C kills many bacteria and fungi. Not all the bacteria and fungi have been killed, though, and so the milk can only be kept for a limited period. After pasteurisation you should keep milk in the refrigerator, in order to slow down the growth of the bacteria and fungi.

**3 Sterilisation**

Milk, for example, is heated to 130 or 140°C . This kills all the bacteria and fungi. After this, the milk is packaged and heated again. These steps have to be done in quick succession, because new bacteria and fungi could get into the milk if it was allowed to cool. Other sterilised foodstuffs may be canned.

**4 Vacuum packing**

Food can also be vacuum packed. This involves sucking all the air out of the packaging. Bacteria and fungi cannot reproduce because there is no oxygen. One example is ground coffee, which is first roasted and then vacuum packed.

**5 Inert atmospheres**

Putting a steak, for example, into packaging that contains the right mixture of gases such as carbon dioxide, oxygen and nitrogen keeps the food good for longer, as well as helping it keep its colour.

**6 Drying**

Removing all the water from food prevents bacteria and fungi from reproducing. Examples of dried products are milk powder, raisins and packet soups.

**7 Irradiation**

Foods are sometimes irradiated with gamma rays from a radioactive source. This makes bacteria and fungi less able to reproduce, or kills them. Irradiation is only permitted where there is a high risk of bacteria and fungi that could make people ill, such as in chicken for instance.

**8 Adding preservatives**

Adding preservatives such as sugar, salt, acids (such as vinegar) or nitrogen make the conditions unfavourable for bacteria and fungi. Examples are the sugar in jam and the salt in fresh herrings and olives.



ADDITIVES

A preservative is an example of an additive. **Additives** are substances that are added to foodstuffs so that they will keep for longer or are more attractive in some way. Sugar, vinegar and salt are natural additives.

Colourings are often added to a food to make it look more attractive. **Aromas** and **flavourings** are sometimes added too. Sweets and ice cream often contain artificial colourings, aromas and flavourings.

It is important for a healthy diet that there are not too many artificial additives in the food. Artificial additives can be harmful, particularly if eaten in large quantities. The preservative sulphite, for example, can give you severe headaches.

There are some foodstuffs that definitely do not contain any synthetic additives; that is then often stated explicitly on the packaging (see figure 70).

WB EXERCISES 50 TO 53, PAGE 83

► Fig. 70



Summary

OBJECTIVE 1

You must be able to state the functions of nutrients and dietary fibre.

- Foodstuffs: any product that you eat or drink.
 - Plant-based foodstuffs: roots, stems, leaves, fruits and seeds of certain plants.
 - Animal-based foodstuffs: parts of animals (meat or fish) or products from animals (eggs and dairy produce, e.g. milk, butter, cheese and yoghurt).
- Nutrients: the usable components of foodstuffs.
 - Building blocks: are used in making cells and tissues (particularly for growth, development and repair in the body).
 - Fuels: provide the energy needed for movement and to keep your body temperature up and for growth, development and repairs to your body.
 - Reserves: are stored in certain parts of the body.
 - Protective substances: keep you healthy.
- Dietary fibre: all the indigestible parts of plant-derived food.
 - Function: to help peristalsis.

OBJECTIVE 2

You must be able to name six groups of nutrients and their functions and features, as well as stating how the presence of starch can be shown with an indicator.

- Proteins.
 - Functions: primarily as building blocks, also as fuel.
 - Proteins cannot be used as reserves.
- Carbohydrates.
 - Functions: primarily as fuel, also as building blocks and reserves.
 - Examples: glucose, sugars, starch and glycogen.
 - Glucose can be converted into glycogen and stored in the liver and in your muscles.
- Fats.
 - Functions: primarily as fuel, also as building blocks and reserves.
 - Fats can also be stored as reserves under the skin.
- Water.
 - Function: building block.
 - Water is important for instance in transporting substances around the body.
- Minerals (salts).
 - Functions: building blocks and protective substances.
 - Example: calcium phosphate for building bones.

- Vitamins.
 - Functions: building blocks and protective substances.
 - Vitamins are identified by letters (for example A, B, C, D and K).
 - Examples: vitamin A for producing skin and seeing well; vitamin D to help the bones take up calcium phosphate.
- Iodine solution is an indicator for starch.
 - Iodine solution changes from light brown to blue-black when starch is present.
- The presence of glucose can be demonstrated with a test strip.
 - The test strip changes colour when glucose is present.

OBJECTIVE 3

You must be able to use information to give advice about a healthy diet.

- Vary your diet: eat something from each of the five sections of the Wheel of Five every day.

	Food products	Needed for
Section 1	fruit and vegetables	vitamin C and dietary fibre
Section 2	bread and potatoes (or rice, macaroni, spaghetti, pulses, couscous)	starch, plant proteins, vitamins, minerals and dietary fibre
Section 3	milk, cheese (or other dairy produce) and meat, meat products, chicken, fish, egg or meat substitutes	(animal) protein, vitamins and minerals (including calcium)
Section 4	margarine, light margarine or oils	fats and vitamins
Section 5	drinks	water

- Don't eat too much.
 - Energy requirements depend among other things on the gender, age, body size and physical activity.
 - A good daily menu consists of three meals and not more than three or four snacks between meals.
 - Do not consume too much fat, sugar or alcohol.

- Do not eat a lot of saturated fat. Animal fats in particular tend to be saturated.
 - Choose light margarine from a tub, liquid fats and oils. These products contain a lot of unsaturated fats.
- Eat plenty of vegetables, fruit and bread.
 - Vegetables, fruit and bread do not contain lots of high-energy substances but do have lots of nutrients. They make you feel full quickly.
- Eat safely.
 - Good food hygiene will help you avoid food poisoning. Food poisoning is an infection caused by eating food that has been contaminated with chemicals, bacteria or other things that make you ill.

OBJECTIVE 4

You must be able to name the causes and consequences of being overweight and underweight. You must be able to say how you can tell if your weight is healthy. You must also be able to list good ways and bad ways of losing weight.

- Overweight: you are heavier than you should be for your age and height.
- Causes of overweight:
 - eating too much;
 - eating too much fatty food;
 - not exercising enough;
 - inherited predisposition.
- Consequences of overweight:
 - you run an increased risk of cardiovascular disease;
 - you are more likely to have problems with your back, neck, knees, ankles and feet.
- Being underweight: you are lighter than you should be for your age and height.
- Causes of underweight:
 - malnutrition due to insufficient food or a lack of certain nutrients, primarily proteins;
 - an eating disorder.
- Consequences of being underweight:
 - you can become ill quickly;
 - you may become anaemic.
- Consequences of a lack of protein in small children:
 - slower growth and development;
 - possible brain damage;
 - swollen bellies.

- Ways of determining whether your weight is healthy:

$$\text{body mass index (BMI)} = \frac{\text{weight (kg)}}{\text{height}^2 (\text{m}^2)} = \text{kg/m}^2$$

- Boys aged 12 to 14 are a healthy weight if their BMI is about 15 to 23 kg/m².
- Girls aged 12 to 14 are a healthy weight if their BMI is about 16 to 23 kg/m².
- Adults are a healthy weight if their BMI is about 20 to 25 kg/m².
- Good ways of losing weight (from easiest to hardest).
 - 1 Eat normal quantities and get more exercise.
 - 2 If you eat snacks, choose something with not much fat or carbohydrates.
 - 3 Eat only the recommended quantities. This often means more bread, more fruit, more vegetables, less meat and less cheese.
 - 4 Always eat the smallest quantities of the recommended amounts.
 - 5 Do not eat any snacks at all in between meals. Do drink enough water, tea or coffee (with no sugar) or 'light' soft drinks.
- Less good ways of losing weight:
 - eating less than the recommended quantities;
 - skipping meals.

OBJECTIVE 5

You must be able to name the possible causes and give examples of eating disorders.

- Causes of eating disorders:
 - influences from your culture or fashions (the ideal of being slim);
 - being dissatisfied with yourself, your bodyweight or your outward appearance.
- Anorexia nervosa: people who want to lose extreme amounts of weight.
 - You may not get enough nutrients.
 - You can become listless.
 - You can get all kinds of illnesses and problems with your stomach and your teeth.
- Bulimia nervosa: people who also do not eat enough, but then do have regular bouts of eating. They vomit to get rid of the food, or use large amounts of laxatives.
- Binge eating disorder (BED): people who also have these moments when they eat a lot, but they do not vomit it back up or use laxatives.
 - You will become heavier.

OBJECTIVE 6

You must be able to state reasons why many people eat less meat. You must also be able to name products that can replace meat in a meal and which nutrients must be present in them in extra quantities.

- Reasons for eating less meat:
 - respect for animals;
 - taking care of your health;
 - religious beliefs;
 - caring for the environment;
 - the global food situation;
 - the taste;
 - the price.
- Products that can replace the meat in the meal: pulses, tofu, cheese, eggs and meat substitutes.
- These products must contain extra amounts of:
 - iron, because the body is less able to absorb iron from plant-based foods;
 - vitamin B12, because there is little or none of this in plant-based foods.

OBJECTIVE 7

You must be able to describe what digestion is and the function of the digestive juices and enzymes in digestion.

- Digestion: the conversion of nutrients that cannot pass through the wall of the gut into the blood into digestion products that can be absorbed into the bloodstream.
 - Proteins, most carbohydrates (including sugars and starches) and fats are digested.
 - Glucose, minerals, vitamins and water do not need to be digested.
- The digestive juices help digestion to take place.
 - Digestive juices are made by the digestive glands.
 - Many digestive juices contain enzymes.
- Enzymes: substances that catalyse the chemical processes.
 - The enzymes in digestive juices make sure that digestion proceeds quickly.

OBJECTIVE 8

You must be able to describe how peristalsis occurs and be able to name its functions.

- Peristaltic movements: alternate contraction and relaxation of the circular muscles and longitudinal muscles in the wall of the entire intestinal tract.
- Functions: to move the food pulp along, kneading and mixing it with digestive juices.

OBJECTIVE 9

You must be able to name the parts of a tooth and their features and functions.

- External structure of a tooth.
 - Crown: part that protrudes from the jaw.
 - Root: the part (or parts) in the jaw.
- Internal structure of a tooth.
 - Dentine.
 - Dental cavity: pulp-filled hollow in the dentine in which the blood vessels and nerves are located.
 - Enamel: very hard layer covering the dentine of the crown.
 - Cementum: a layer around the dentine of the roots.
 - Periodontal membrane: attaches the tooth into the jaw. (The jaws are covered by the gums.)

OBJECTIVE 10

You must be able to name the milk teeth and permanent teeth along with their functions and features, as well as being able to create and read a dental formula.

- Incisors and canines are for biting pieces off the food.
 - Canines are somewhat more pointed than incisors.
- Molars are for grinding the food up finely.
 - Molars have a knobbly surface.
- Milk teeth.
 - Appear between ages six months and two years.
 - Each jaw half has 2 incisors, 1 canine and 2 molars.
 - Dental formula:

2 . 1 . 2	2 . 1 . 2
2 . 1 . 2	2 . 1 . 2
- Permanent teeth.
 - Appear from the age of about six, replacing the milk teeth.
 - Each jaw half has 2 incisors, 1 canine and 5 molars, one of which is a wisdom tooth. (The wisdom teeth are often too small for chewing food properly. It is also possible that they may not appear, or that they have to be taken out shortly after they do appear.)

- Dental formula:

5 . 1 . 2	2 . 1 . 5
5 . 1 . 2	2 . 1 . 5

OBJECTIVE 11

You must be able to describe what dental plaque is, list its consequences and say what you can do to counteract it.

- Plaque: a thin layer that is left behind on the teeth every day.
 - It consists of residues of food, saliva and a lot of bacteria.
- Consequences of dental plaque.
 - Bacteria in plaque convert sugars from the food into acids. The acid dissolves the enamel from the teeth.
 - The bacteria in plaque can cause gum disease. This can result in the periodontal membranes becoming inflamed, which in the end can make the teeth come loose.
 - Plaque can harden and become tartar. You cannot remove tartar yourself.
- You can reduce plaque by:
 - brushing properly two or three times a day;
 - not eating snacks more than three times a day.

OBJECTIVE 12

You must be able to state the parts of the digestive system with their functions and characteristics.

- Oral cavity with teeth and salivary glands.
 - Functions of the teeth: to break the food up into small pieces (chewing), so that it can be swallowed more easily. This also increases the surface area of the food, so that enzymes have more surface area to work on.
 - Function of salivary glands: to produce saliva.
- Oesophagus (gullet).
 - Function: to move the food from the pharynx to the stomach.
- Stomach.
 - Function: temporary storage of the food.
 - Pyloric sphincter: circular muscle that closes off the stomach.
 - The gastric glands produce gastric juice.
- Liver.
 - Function: to produce bile.
 - Bile is stored temporarily in the gall bladder and secreted from there via the bile duct.
- Pancreas.
 - Function: to produce pancreatic juice.
- Duodenum.
 - Function: to mix the bile and pancreatic juices with the food pulp.

- Small intestine.
 - Function: to absorb nutrients, digestion products and water into the blood.
 - The wall has intestinal folds and villi, giving it a large surface area. The intestinal villi contain numerous blood vessels.
 - The intestinal glands produce intestinal juice.
- Caecum with vermiform appendix.
 - In appendicitis, the vermiform appendix is inflamed (although the Dutch word confusingly suggests the caecum is inflamed).
- Large intestine.
 - Function: to remove water from the pulp of undigested food residues, which thereby becomes thicker. The water is absorbed into the bloodstream.
 - In diarrhoea not enough water is absorbed into the blood from the small intestine and large intestine.
 - Bacteria digest cellulose from the cell walls of plant-based food residues. This produces glucose, which is partly absorbed into the bloodstream.
- Rectum.
 - Function: to collect and provide temporary storage for undigested food residues (faeces).
 - Anus: sphincter that closes off the rectum.

OBJECTIVE 13

You must be able to list the digestive juices and their functions.

- Saliva: water, mucus and an enzyme.
 - Function of the mucus: to make the food more slippery.
 - Function of the enzyme: partial digestion of starch.
- Gastric juice: water, hydrochloric acid and an enzyme.
 - Function of the hydrochloric acid: to kill bacteria in the food.
 - Function of the enzyme: partial digestion of proteins.
- Bile: contains no enzymes.
 - Function: emulsification of fats (break large drops up into small droplets), so that the enzymes can get at the fats better.
- Pancreatic juice: contains various enzymes.
 - Function: digestion of proteins, carbohydrates and fats.
- Intestinal juice: contains various enzymes.
 - Function: to complete the digestion of proteins and carbohydrates.

EXTRA OBJECTIVE 14

You must be able to state the relationship in mammals between the choice of diet, the length of the intestinal tract and features of their teeth.

- Plant-based food is harder to digest than animal-based food, because the plant-based food contains cell walls made of cellulose.
- Herbivores.
 - The intestinal tract is relatively long in comparison to the body length.
 - The molars are ridged to help them grind the plant-based food up small. The ridges are perpendicular to the direction of the chewing motion.
 - There are often no canines.
- Carnivores.
 - The intestinal tract is relatively short in comparison to the body length.
 - The molars are pointed for shearing and cutting the animal food into pieces. The upper jaw is wider than the lower jaw.
 - The canines are mostly large, pointed and sharp.
- Omnivores.
 - The intestinal tract is medium length in comparison to the body.
 - The molars have bumpy, knobbly surfaces that help both cut and grind the food.
 - Omnivores generally do have canines.

EXTRA OBJECTIVE 15

You must be able to list ways in which food can be preserved.

- Preserving: treating the food so that it does not spoil.
 - Preserving food makes the conditions unfavourable for bacteria and fungi.
- Freezing (e.g. meat): taking the temperature down to -20°C (or lower).
 - Bacteria and fungi are inactive at these temperatures.
- Pasteurisation (e.g. milk): heating to a temperature (72°C) at which most bacteria and fungi are killed. Pasteurised milk should be kept in the refrigerator.
- Sterilisation (e.g. milk): heating to a temperature (130 to 140°C) at which all bacteria and fungi are killed.
 - Many foods (e.g. vegetables) are sterilised and then canned (airtight packaging).
- Vacuum packing: all the air is sucked out of the packaging (e.g. coffee is vacuum packed after roasting).

- Inert atmosphere: under the correct mixture of gases, foodstuffs can be kept longer, as well as keeping their colour for longer (e.g. meat).
- Drying (e.g. milk powder and raisins): removing the water from the food.
- Irradiation (e.g. chicken): using gamma rays (from a radioactive source) so that bacteria and fungi will be killed or able to reproduce less quickly.
- Adding natural preservatives: bacteria and fungi cannot handle too much sugar, acid, salt or nitrogen.
 - A lot of sugar is added to jam.
 - A lot of salt is added to fresh herrings and olives.
- Adding artificial preservatives: e.g. sulphites in drinks.
- Additives: substances that are added to foodstuffs so that they will keep for longer or are more attractive in some way (e.g. preservatives, aromas, colourings and flavourings).

SKILLS AND COMPETENCIES**BASICS**

- You have learned how to read off or calculate the body mass index.
- You have learned what you can tell from the packaging of foodstuffs.
- You have learned how to use the online 'Eetmeter' program.
- You have learned how to test for the presence of starch and glucose in foodstuffs.
- You have practised doing a practical investigation.
- You have learned how to demonstrate how saliva works.

EXTRA

- You have practised making true-to-life drawings.

The diagnostic test does not include any questions about these competencies/skills.

You have met a dietician in this unit. You have also seen applications in science and daily practice that use the material from this unit.

Diagnostic test

You can use this test to check for yourself whether you understand and can apply the objectives listed in the summary. Write down the answers on the score sheet in your workbook.

OBJECTIVE 1

Answer the following questions.

- 1 What are nutrients?

Questions 2 and 3 are about figure 71.

- 2 Do these foodstuffs contain a lot of building blocks?
- 3 And do they contain a lot of dietary fibre?
- 4 What is the relationship between fuels and your body temperature?
- 5 What is the function of the substances that are primarily stored under the skin?
- 6 Why is dietary fibre not a nutrient?



▼ Fig. 71

OBJECTIVE 2

The score sheet shows a table of the six groups of nutrients. Answer the following questions by placing crosses in the correct column or columns.

- 1 Which groups act as building blocks in your body?
- 2 Which groups act as fuels in your body?
- 3 Which groups act as food reserves in your body?
- 4 Which groups act as protective substances in your body?
- 5 What group of nutrients does the product in figure 72 belong to?
- 6 What group of nutrients can be stored under the skin?
- 7 Which nutrient is used for transporting substances around your body?
- 8 What group includes the nutrient whose presence you can test for using iodine solution?

▼ Fig. 72

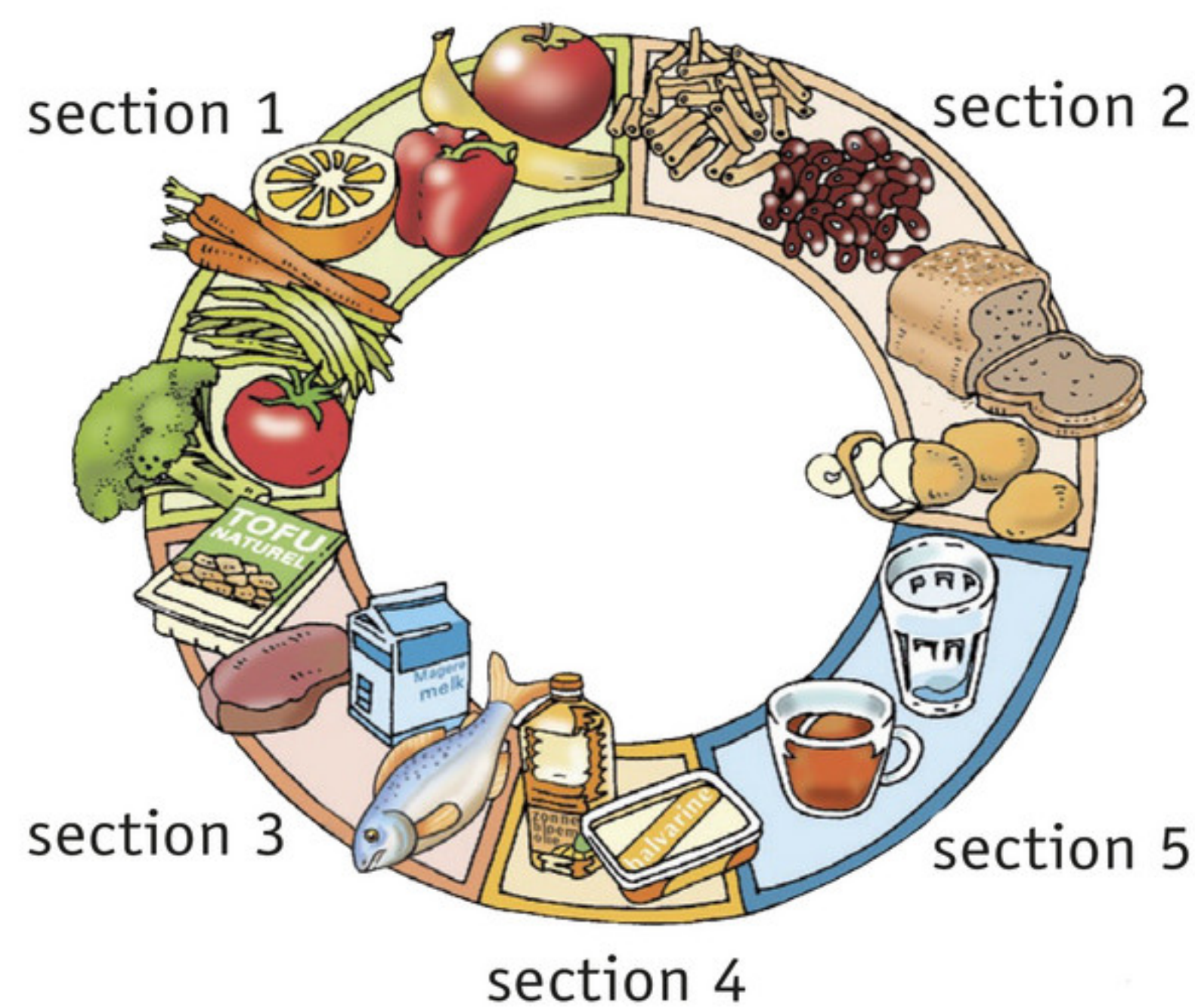


OBJECTIVE 3

Answer the following questions.

The drawing in figure 73 represents the Wheel of Five with several types of food.

- 1 The Netherlands Nutrition Centre recommends that you should eat or drink something from each of the five sections every day. Why does the Netherlands Nutrition Centre recommend this?
- 2 Nutrients from sections 1 and 2 should be the basics of your diet. State two reasons why this is important.
- 3 Figure 74 shows a photo of tempeh, which is similar to tofu. Which of the sections does this foodstuff belong to?
- 4 Which of the sections does couscous belong to?



▼ Fig. 73



▼ Fig. 74

5 Figure 75 shows you two products that you can fry chips (French fries) in. Martin says that it is healthier to fry your chips in product 1 than in product 2. Is this statement correct? Explain your answer.



▼ Fig. 75

In one of its folders, the Netherlands Nutrition Centre recommends that adult men and women should eat certain quantities of particular foodstuffs every day (see table 4).

Questions 6 and 7 are about this table.

- 6 Marcie says that women are recommended to eat larger quantities of high-energy foodstuffs than men. Is this statement correct? Explain your answer.
- 7 A pupil is given the task of calculating how much food containing carbohydrates a woman should eat per day, according to the recommendations. He looks at the table of recommended quantities and works it out as follows: 175 g (bread) + 200 g (potatoes / rice / pasta / pulses) = 350 g.

His teacher says that the calculation is not correct. She says, “You need more than just the data from the table for this assignment.” What other data does the pupil need if he is going to do the calculation correctly?

▼ Table 4 Recommended daily amounts.

Product	Man	Woman
Cheese	30 g	30 g
Other dairy products	300 g	300 g
Red meat / chicken / fish / soya products (meat substitutes)	125 g	100 g
Margarine / butter / fat / oil	50 g	35 g
Bread	235 g	175 g
Potatoes / rice / pasta / pulses	250 g	200 g
Vegetables	200 g	200 g
Fruit	200 g	200 g

The composition of various foodstuffs is given in table 5.

- 8 A dietician tells someone who wants to lose weight that 100 g of chips contains more energy than 100 g of boiled potatoes. Explain why the dietician is correct. Give three arguments for this and use the data from the table.
- 9 A meal consists of 100 g fried steak, 50 g lettuce and 200 g of chips. How many grams of protein does this meal contain in total? Include your calculation with your answer.

▼ Table 5 The composition of a number of foods. The figures are for 100 g of the edible part of the food product.

	Water (g)	Protein (g)	Fats (g)	Carbohydrates (g)	Minerals (mg)	B vitamins (mg)	Vitamin C (mg)
Potatoes (boiled)	76	2	0	17	460	0.34	variable
Chips (bought ready to eat)	37	5	15	38	930	0.43	3
Steak (fried)	70	27	3	0	353	0.50	0
Lettuce	96	2	0	1	385	0.20	10

OBJECTIVE 4

Answer the following questions.

- 1 Can too little exercise cause overweight? Explain your answer.
- 2 Lack of protein in the diet of small children can cause swollen bellies.
State two more consequences.
- 3 Do people who are overweight run a lower risk of getting cardiovascular diseases than people with a healthy weight?
- 4 Joe is 2 m tall and he weighs 100 kg.
What is his BMI?
- 5 What is the range of BMI values for adults with a healthy weight?
- 6 What is the easiest way to lose weight?

OBJECTIVE 5

Fill in the missing words on your score sheet.

- 1 One cause of eating disorders can be that you are influenced by fashion or ...
- 2 You may also be dissatisfied with yourself, your ... or your ...
- 3 Someone who generally does not eat enough but sometimes has bouts of eating a lot has ...
- 4 Someone who always eats far too little and is afraid of putting on weight has ...
- 5 Someone with this eating disorder (question 4) can get problems with their stomach and ...

OBJECTIVE 6

Say whether each of the following statements is true or false.

- 1 Some people are vegetarians because they are worried about the environment.
- 2 Some people are vegetarians because they think it is a bad thing that there is so much hunger in the world.
- 3 A vegetarian is highly likely to suffer from a lack of vitamin C.
- 4 Our bodies are better at getting iron from plant-based foods than animal-based foods.
- 5 An egg is a good substitute for meat.

OBJECTIVE 7

Answer the following multiple choice questions.

- 1 Two students are talking about digestion.
Liam says that digestion is the conversion of nutrients that cannot pass through the wall of the gut into the blood into digestion products that can be absorbed into the bloodstream.
Rowena says that the enzymes that allow digestion to progress quickly come into the body with the food you eat.
Who is right?
 - A Only Liam is right.
 - B Only Rowena is right.
 - C Liam and Rowena are both right.
 - D Neither Liam nor Rowena is right.
- 2 Are minerals digested by the enzymes in human digestive juices?
What about fats? And vitamins?
 - A Only minerals.
 - B Only fats.
 - C Only vitamins.
 - D Both fats and vitamins.
- 3 Which carbohydrate can be absorbed directly from our intestinal tracts into the blood without having to be digested first?
 - A Cellulose.
 - B Glucose.
 - C Sugar.
 - D Starch.

OBJECTIVE 8

Answer the following questions.

- 1 Do the longitudinal and circular muscles in the gut wall contract at the same time or alternately?
- 2 If you have eaten spoiled meat, is peristalsis increased or reduced? Explain your answer.
- 3 Medicines can be used to halt peristalsis in the intestines.
Can the food then be digested quickly? Explain your answer.

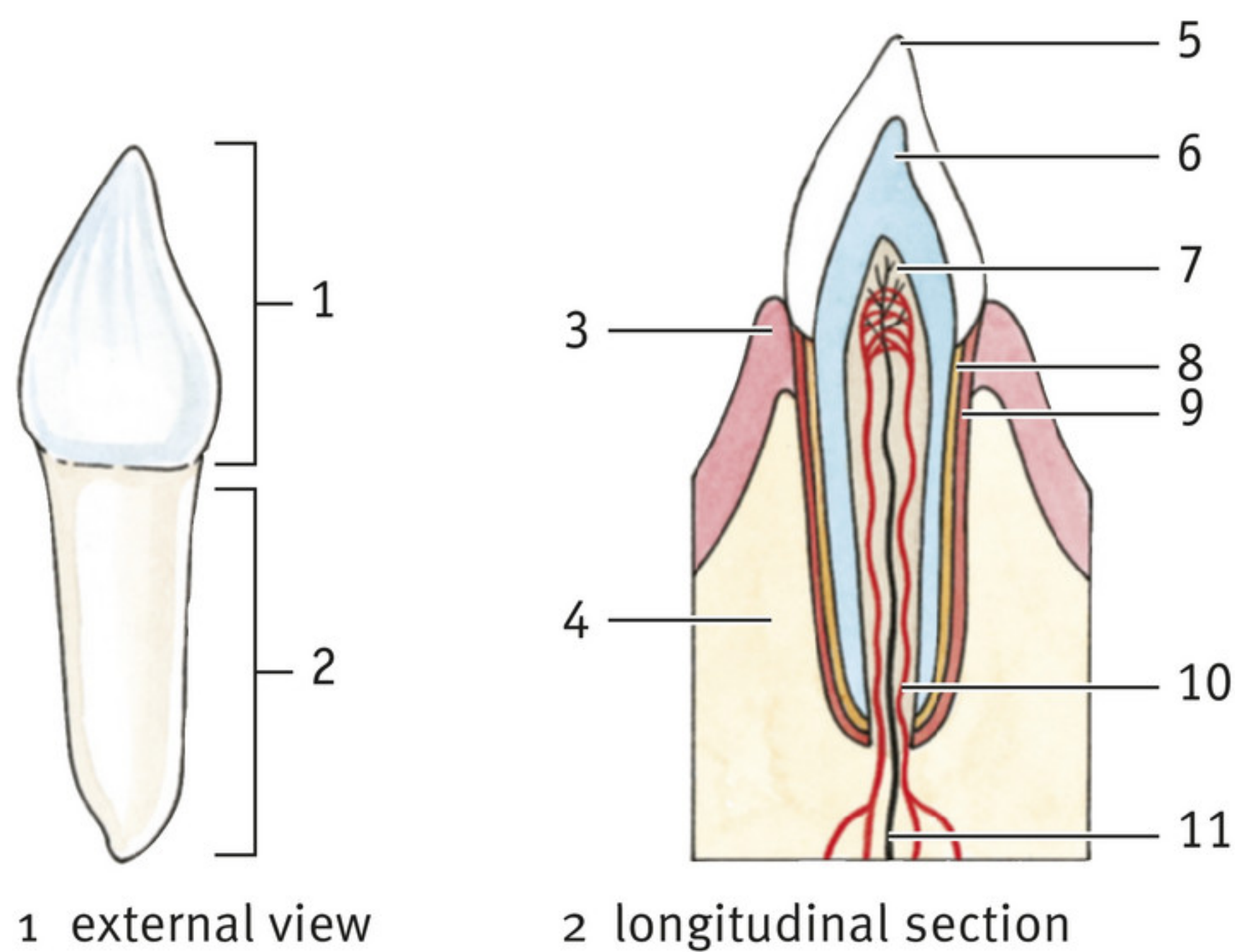
OBJECTIVE 9

Figure 76 shows an external view and a longitudinal section of a tooth.

Answer the following questions.

- 1 What is the name of part 1?
- 2 What is the name of part 8?
- 3 What number indicates the dentine?
- 4 Which number shows a nerve?
- 5 Which number points to the part that anchors the tooth in the jaw?
- 6 Which number indicates the hardest part of the tooth?

▼ Fig. 76 A tooth (schematic).



OBJECTIVE 10

Answer the following questions.

Incisors, canines and molars are all teeth.

- 1 What kind of teeth does figure 77 show the chewing surface of?
- 2 Which two types of teeth are used for cutting off food?
- 3 What kind of tooth is labelled P in figure 78?
- 4 What kind of tooth is labelled Q in figure 78?
- 5 How many incisors are there in the upper jaw in a full set of milk teeth?
- 6 How many molars are there in the left half of the lower jaw in a full set of permanent teeth?
- 7 How many wisdom teeth are there in total in a complete set of permanent teeth?
- 8 A bat has the following dental formula.

$$\begin{array}{c|c} 5.1.2 & 2.1.5 \\ \hline 5.1.3 & 3.1.5 \end{array}$$

How many incisors, canines and molars does a bat have?

- 9 A horse has 6 incisors, 2 canines and 12 molars in the upper jaw and 6 incisors, no canines and 12 molars in the lower jaw. The numbers of teeth in the left and right halves of the jaw are the same. Write down the dental formula of a horse.
- 10 Figure 79 shows a schematic drawing of a dog's teeth. Write down the dental formula of a dog.

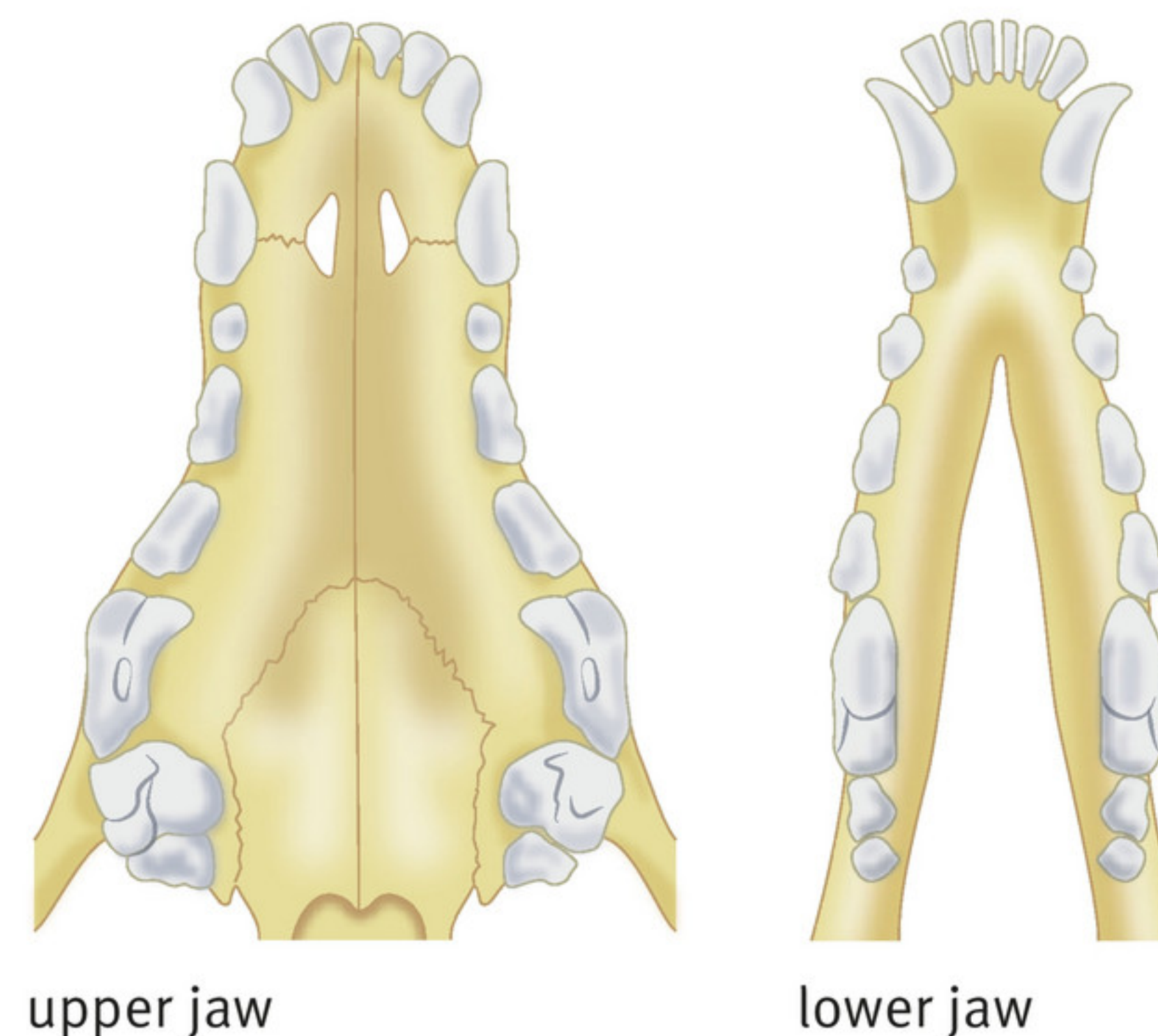
▼ Fig. 77



▼ Fig. 78



▼ Fig. 79 Teeth of a dog (schematic).



OBJECTIVE 11

Answer the following questions.

- 1 Which part of a tooth provides protection against tooth decay?
- 2 Which component of dental plaque do bacteria feed on?
- 3 Cavities are caused in part by bacteria. How do the bacteria do that?
- 4 The bacteria in plaque can be a cause of teeth coming loose. How do the bacteria do that?
- 5 Why is it annoying if plaque is left on your teeth for too long?

OBJECTIVE 12

Answer the following multiple choice questions.

- 1 Emily says that chewing makes the food easier to swallow.
Ricky says that chewing food gives it a smaller surface area.
Who is right?
 A Neither Emily nor Ricky is right.
 B Only Emily is right.
 C Only Ricky is right.
 D Emily and Ricky are both right.
- 2 The following is known about a specific part of the human intestinal tract:
 - 1 This part can be closed off by a circular muscle.
 - 2 A digestive juice is produced there.
 - 3 Food is stored there temporarily.
 Which part of the intestinal tract is this referring to?
 A The large intestine.
 B The small intestine.
 C The rectum
 D The stomach.

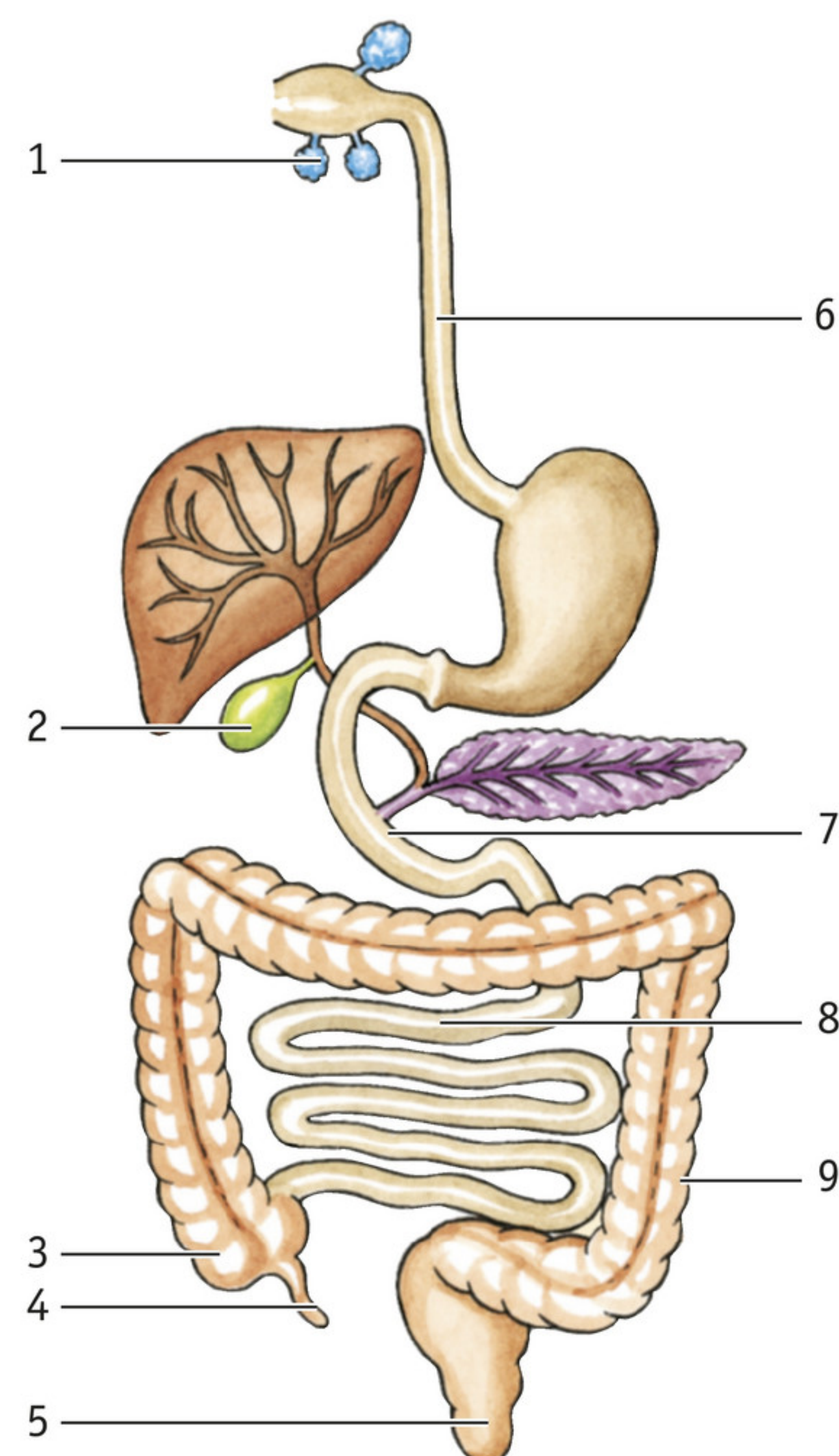
Use the following information to answer questions 3 to 5.

Figure 80 shows a schematic drawing of the digestive system.

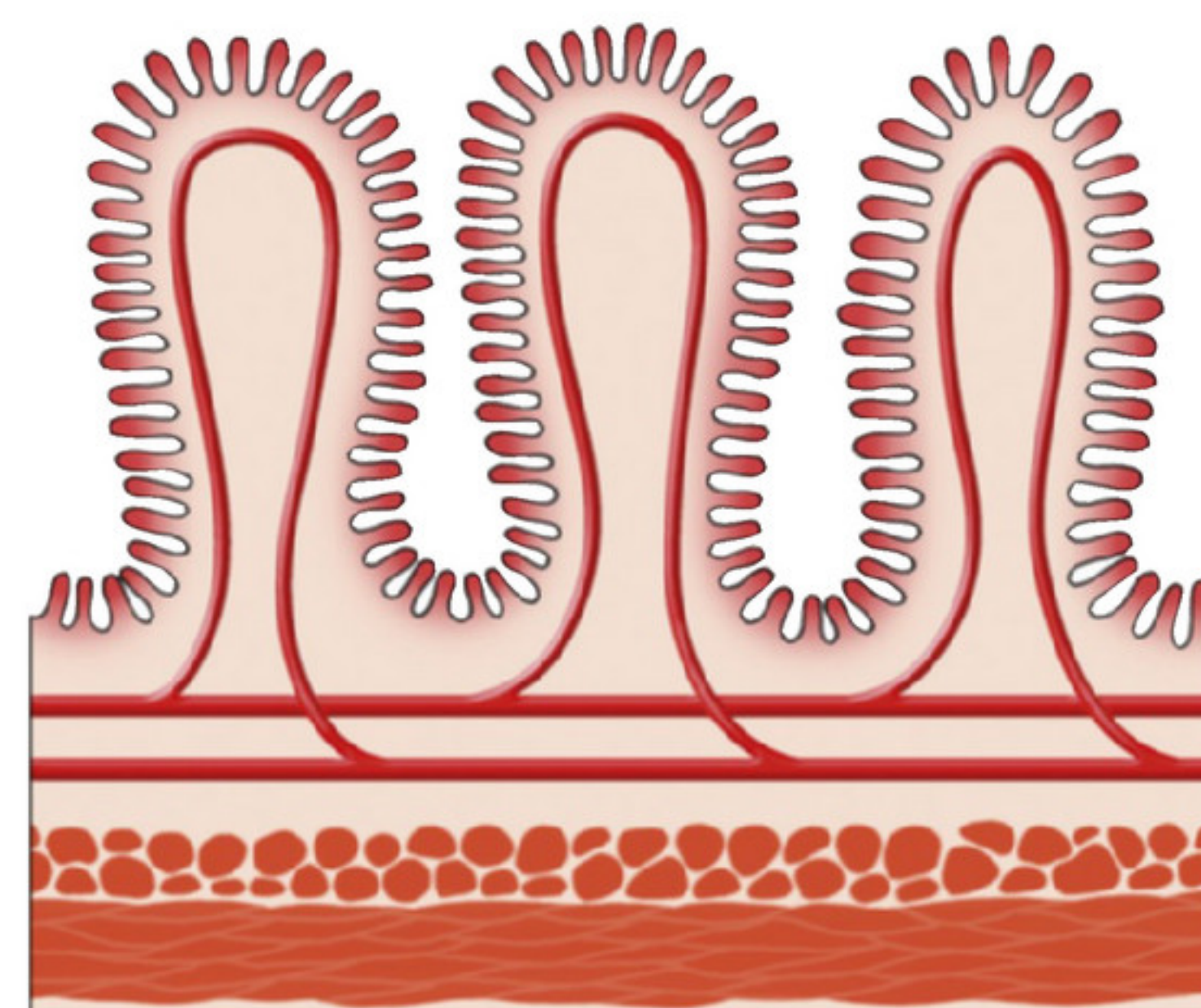
- 3 What is the name of part 1?
 A Pancreas.
 B Oral cavity.
 C Oesophagus.
 D Salivary gland.

- 4 Which part is inflamed in appendicitis?
 A Part 2.
 B Part 3.
 C Part 4.
 D Part 5.
- 5 Figure 81 is a schematic diagram of part of the wall of the intestinal tract.
 Which part of the intestinal tract (see figure 80) is this part of the wall of?
 A Part 6.
 B Part 7.
 C Part 8.
 D Part 9.

▼ Fig. 80



▼ Fig. 81



- 6 From which part of the intestinal tract is a great deal of water absorbed into the blood?
- Only in the large intestine.
 - Only in the large and small intestines.
 - Only in the small intestine and the duodenum.
 - In the large and small intestines and the duodenum.
- 7 Which part of the digestive system produces bile? And where is bile stored?
- The gall bladder produces bile, which is stored in the liver.
 - The gall bladder produces bile, which is stored in the duodenum.
 - The liver produces bile, which is stored in the gall bladder.
 - The liver produces bile, which is stored in the duodenum.
- 8 The parts of a cow's digestive system have the same names as in a human. The exception is the stomach, which is made up of several parts.
In a cow, gases can leave the intestinal tract by belching or by passing wind. Two components of a cow's digestive system are the oesophagus and the rectum.
Which of these two components does a belch pass through before it leaves the cow's body?
And which of these two components does wind pass through before it leaves the cow's body?
- | <i>Belches go through</i> | <i>Wind goes through</i> |
|---------------------------|--------------------------|
| A the rectum. | the rectum. |
| B the rectum. | the oesophagus. |
| C the oesophagus. | the oesophagus. |
| D the oesophagus. | the rectum. |
- 9 Many foods contain fibres. Many of those fibres cannot be digested by human digestive enzymes, but can be digested by bacterial enzymes.
Which part of the intestinal tract do these bacteria predominantly live in?
- In the large intestine.
 - In the small intestine.
 - In the stomach.
 - In the duodenum.

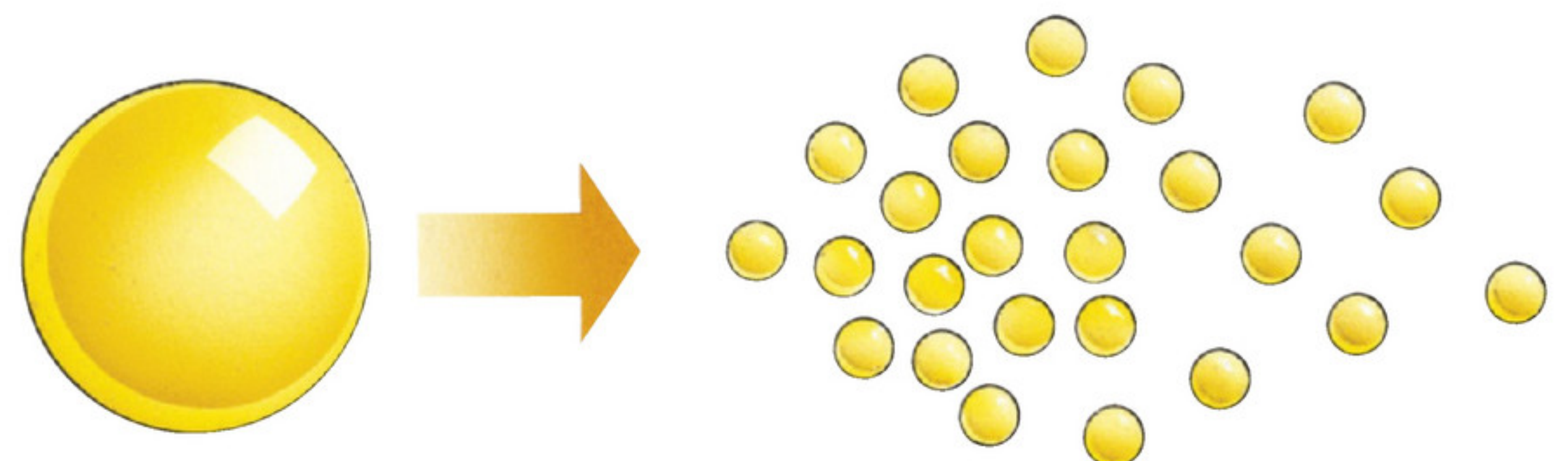
- 10 In which part of the gut are most of the digestion products absorbed into the blood?
- In the small intestine.
 - In the stomach.
 - In the gullet.
 - In the duodenum.

OBJECTIVE 13

The score sheet shows a table of the five digestive juices. Answer the following questions by placing crosses in the correct column or columns.

- The function of a particular digestive juice is shown in figure 82.
Which digestive juice has this function?
- Which digestive juice contains enzymes for digesting proteins, carbohydrates and fats?
- Which digestive juice contains only an enzyme for digesting starch?
- Which digestive juice contains only an enzyme for digesting proteins?
- Which digestive juice contains enzymes that complete the digestion of proteins and carbohydrates?
- Which digestive juice does not contain an enzyme?
- Which digestive juice contains a substance that kills bacteria?
- Which digestive juice contains mucus that helps make food more slippery?

▼ Fig. 82



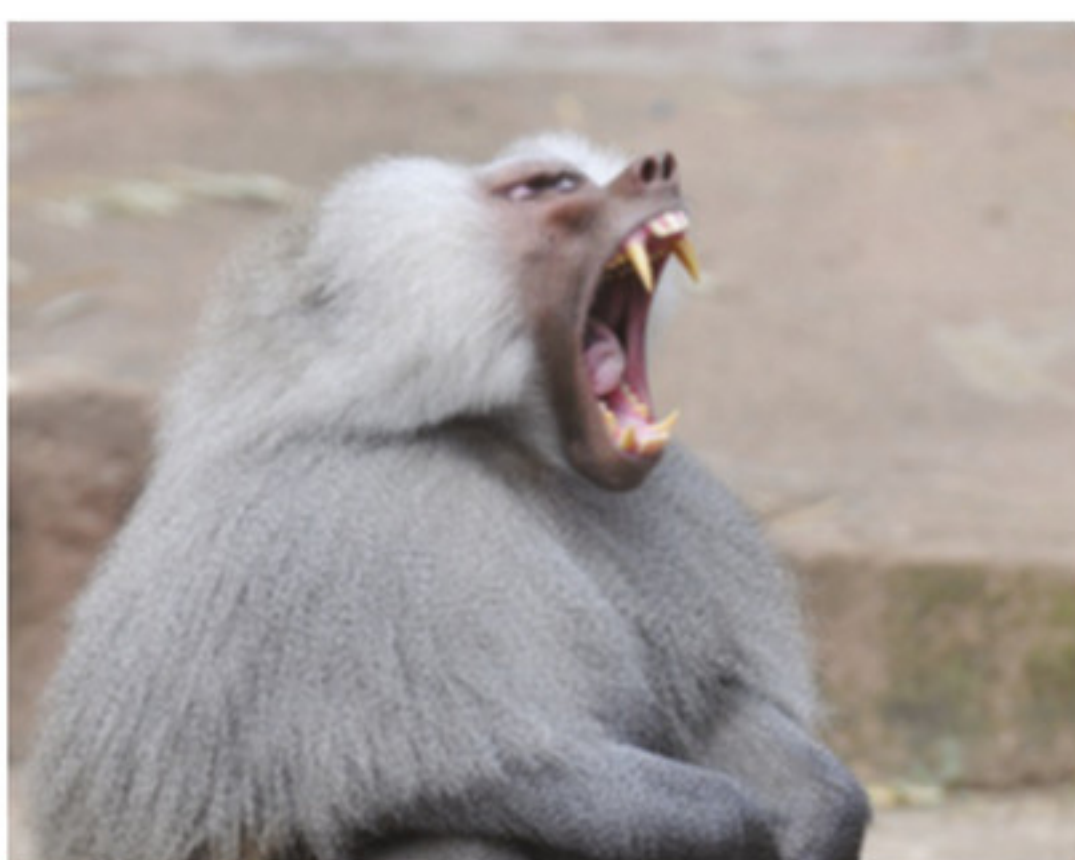
EXTRA OBJECTIVE 14

Answer the following multiple choice questions.

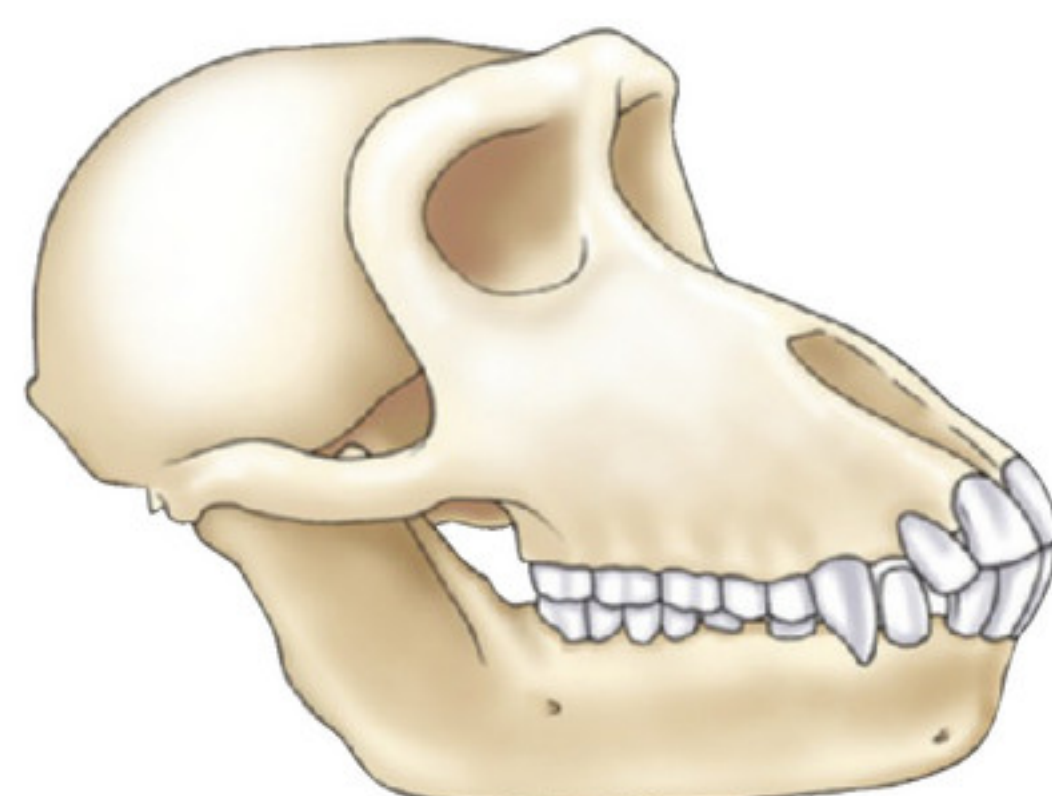
- A proboscis monkey (see figure 83) lives in tropical jungles, where it eats leaves, flowers and fruit.
Is the proboscis monkey a carnivore, a herbivore or an omnivore?
- A carnivore.
 - A herbivore.
 - An omnivore.

▼ **Fig. 83** A proboscis monkey.

- 2 A weasel has sharp, pointed molars and a short intestinal tract for its body length. Do the pointed molars indicate that weasels are carnivores? Does the short intestinal tract also suggest this?
- A Only the pointed molars.
 - B Only the short intestinal tract.
 - C Both the pointed molars and the short intestinal tract.
- 3 Figure 84 shows you a hamadryas baboon and the skull of the same animal. Is a hamadryas baboon an omnivore, a herbivore or a carnivore?
- A An omnivore.
 - B A herbivore.
 - C A carnivore.

▼ **Fig. 84**

1 hamadryas baboon



2 skull

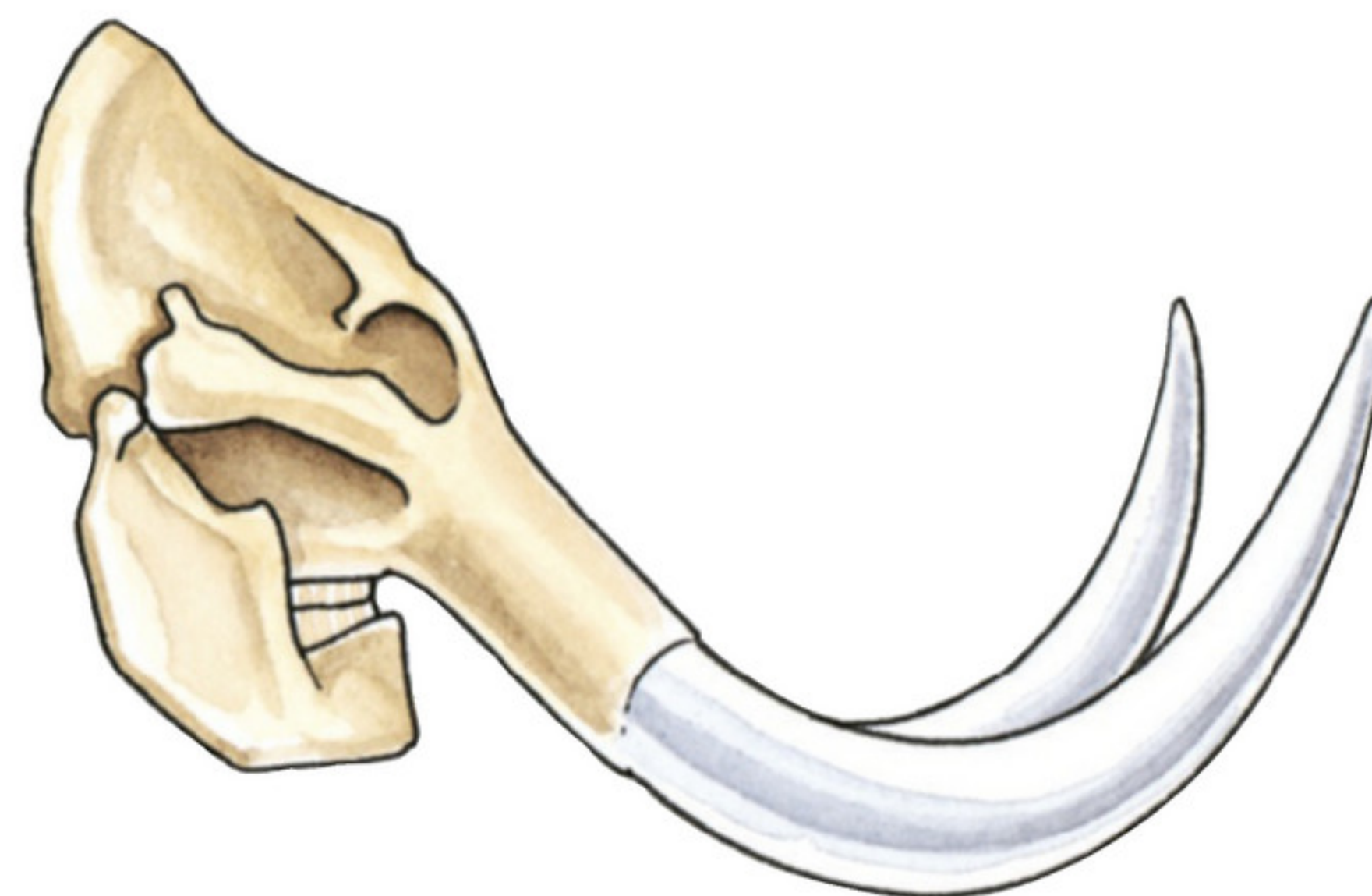
Use the following information to answer questions 4 and 5.

Mammoths are an extinct species of elephant-like animals. Figure 85 shows a drawing of the skull and the top view of a molar of a mammoth.

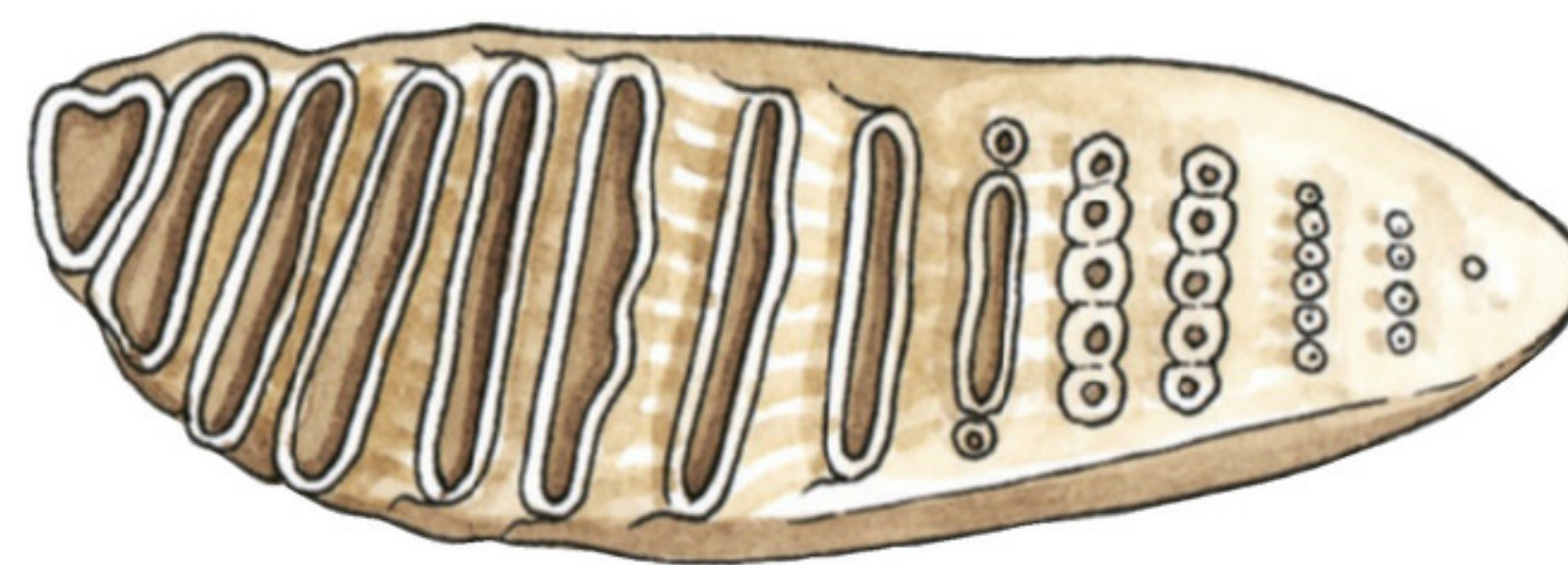
The mammoth molars that have been found tell us about the kind of food that these extinct animals used to eat.

Complete frozen mammoths have been found in the Siberian permafrost. The stomach contents of these frozen mammoths can also be studied.

- 4 What type of molars did mammoths have?
- A Pointed.
 - B Knobbly.
 - C Ridged.
- 5 What type of food residues will have been found in the stomachs of the frozen mammoths?
- A Only the residues of animal-based foods.
 - B Only the residues of plant-based foods.
 - C Residues of both animal and plant-based food.

▼ **Fig. 85** Mammoth.

1 skull



2 molar

EXTRA OBJECTIVE 15

Answer the following multiple choice questions.

- 1** Grapes go off quickly. Raisins (see figure 86) can be made from grapes. Raisins can be kept for a long time.

Why do raisins not spoil nearly as quickly as grapes?

- A** Because raisins contain less sugar than grapes.
- B** Because a lot of sugar is added to the raisins.
- C** Because raisins contain less water than grapes.
- D** Because the raisins are heated strongly during the production process.

▼ **Fig. 86**



1 grapes

2 raisins

- 2** Red beet juice is often added to strawberry ice cream or yoghurt. This gives it a brighter colour. Is red beet juice an additive?

And is red beet juice a preservative?

Additive Preservative

- A** yes yes
- B** yes no
- C** no yes
- D** no no

- 3** Food can be preserved by adding natural preservatives.

What preservative is added to the foodstuff shown in figure 87?

- A** Nitrogen.
- B** Sugar.
- C** Salt.
- D** Water.

▼ **Fig. 87** Olives.



- 4** Consider the following three foods: milk powder, liquid coffee creamer (sterilised) and fresh milk (pasteurised).

Which of these three foodstuffs would you expect to find in the refrigerated section at the supermarket?

- A** Only the coffee creamer.
- B** Only the fresh milk.
- C** Only the coffee creamer and the fresh milk.
- D** All three of the foods.

- 5** Which method of preservation is mostly used for ground coffee?

- A** Additives are usually added to ground coffee.
- B** Ground coffee is usually irradiated.
- C** Ground coffee is usually vacuum packed.
- D** Ground coffee is usually dried.

You can do the extension if you have time left over. You can choose between different topics. This unit's extension consists of three topics. You can do the exercises for them in your workbook. Your teacher will tell you how many topics you should choose.

1

Product information

In this extension, you will learn what information should be on the packaging of foodstuffs. You have to find two food labels at home and answer questions about them.

▼ Fig. 88 Product information.



1 gherkins



2 tomato ketchup

▼ Fig. 89 The nutritional information included in the product information.

Voedingswaarde	Per 100 ml	Per kom 250 ml (250 ml)	% GDA
Energie	230 kJ (55 kcal)	580 kJ (140 kcal)	7%
Eiwitten	2 g	5 g	
Koolhydraten	8,5 g	21 g	16%
waarvan suikers	5,5 g	14 g	6%
Vet	1,5 g	4 g	5%
waarvan verzadigd vet	0,4 g	1 g	
Voedingsvezel	1 g	2,5 g	37%
Natrium	0,35 g	0,89 g	

* van de Dagelijkse Voedingsrichtlijn (GDA) op basis van 2000 kcal
Voor vragen, klachten of

The packaging of a food gives information about its contents (see figure 88). This is called the **product information**. The manufacturer is legally required to state the name of the product, the name of the manufacturer, the net quantity, the 'best before' date and the list of ingredients on the packaging. The packaging must also state a number: the **production code** or **batch code**. This makes it possible to trace exactly where and when a product was made. In the event of the food being contaminated, it is then possible to see what other packages were probably contaminated too.

After the volume, you will often see a large letter 'e' (see figure 88.2). That 'e' is the first letter of the word **estimate** (i.e. it is an estimated volume). The actual volume may not differ from the stated volume by more than a given amount.

Packaged foodstuffs have a **'best before' date**, which in the Netherlands is indicated by 'Ten minste houdbaar tot' or 'THT' and a date. Until that date, the manufacturer guarantees the product quality, as long as it has been stored correctly in the closed packaging. Milk, dairy products, meat and other produce that can spoil quickly should definitely not be kept beyond the 'best before' date indicated. The **storage instructions** tell you how to store the product.

The **ingredients** are the raw materials that the product is made from. They are listed on the packaging in sequence of decreasing quantity in the product. The list of ingredients also states any additives that have been added. Additives that do not present any danger to health are given **E numbers** (see figure 88.1). These substances are allowed to be used in all European countries. Some people may be hypersensitive (allergic) to certain additives. They can then use the E numbers to see if they will be able to tolerate a particular food. Additives that only have a number (without the E) are only permitted in some European countries.

It is becoming increasingly common for the manufacturers to also state **nutritional information** about the product (see figure 89). The packaging then states how much energy, fat, protein and carbohydrate is in the product, usually per 100 g or per 100 mL. Minerals and vitamins are sometimes listed too. The amount of energy is usually quoted in both kilojoules and kilocalories.

2 Puzzle

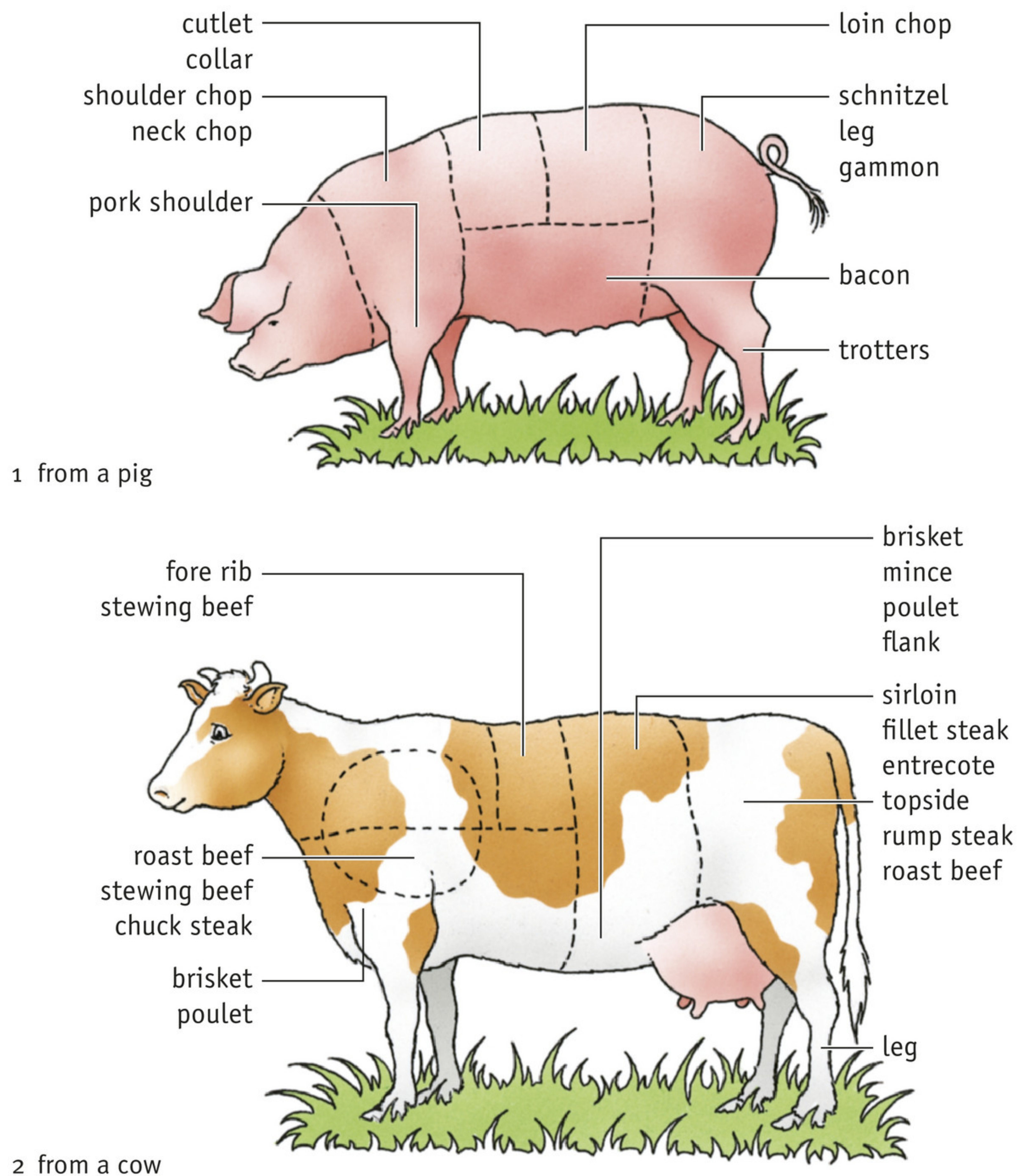
In the basics, you have learned all sorts of new words. You will find the descriptions of a number of those words in your workbook. This extension requires you to fill those words into a puzzle.

WB EXERCISE 1, PAGE 91

3 Which parts of an animal do you eat?

In this extension, you will learn exactly what you are eating when you eat meat. You have to fill in a table and answer questions.

▼ Fig. 90 Sorts of meat.



You can buy meat from all kinds of animals in the Netherlands, such as pigs, cows, chickens, sheep and horses.

Animals provide different kinds of meat. The type of meat depends on which part of the animal is used. Figure 90 shows which parts of a pig and a cow are used for what kind of meat.

Meat comes primarily from the muscles of the animal. Muscles contain a large amount of protein. Some types of meat also contain bones or pieces of cartilage. There is also fat in meat. Bacon comes from a pig. The rind of the bacon is the animal's skin (see figure 91). The lean part is meat from muscles. Between the lean part and the rind, there is a layer of fat.

Meat contains quite a lot of water. When the meat is prepared, some of that moisture is lost. After preparation, 100 grams of raw meat only leaves about 75 grams.

Meat can also come from the internal organs of animals, for instance the liver or kidneys. This is sometimes called **offal**. Animals may take in harmful substances along with their food. These substances end up in the internal organs in particular. The Netherlands Nutrition Centre therefore recommends not eating offal too often.

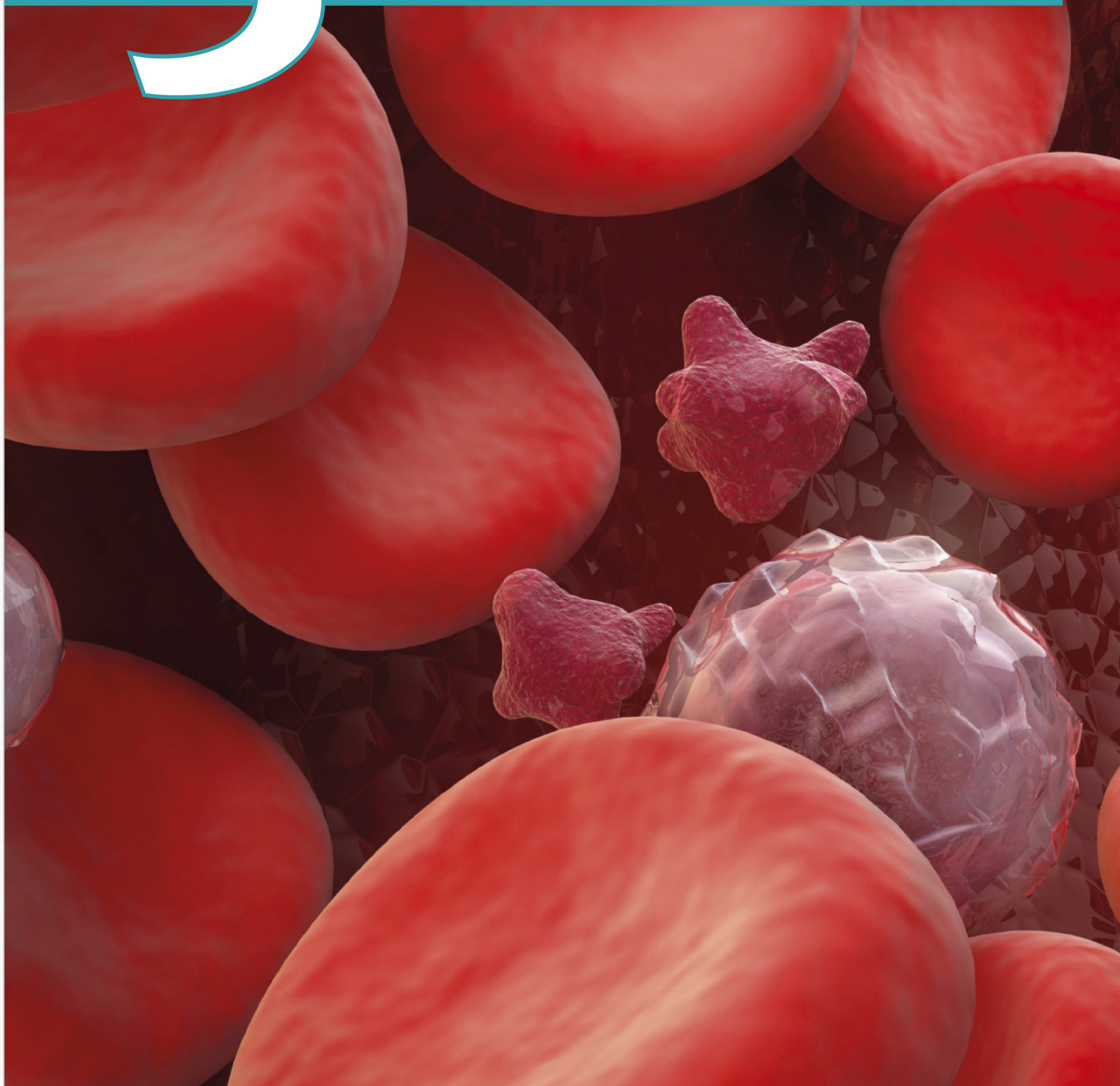
WB EXERCISES 1 AND 2, PAGE 93

► Fig. 91



3

The circulatory system



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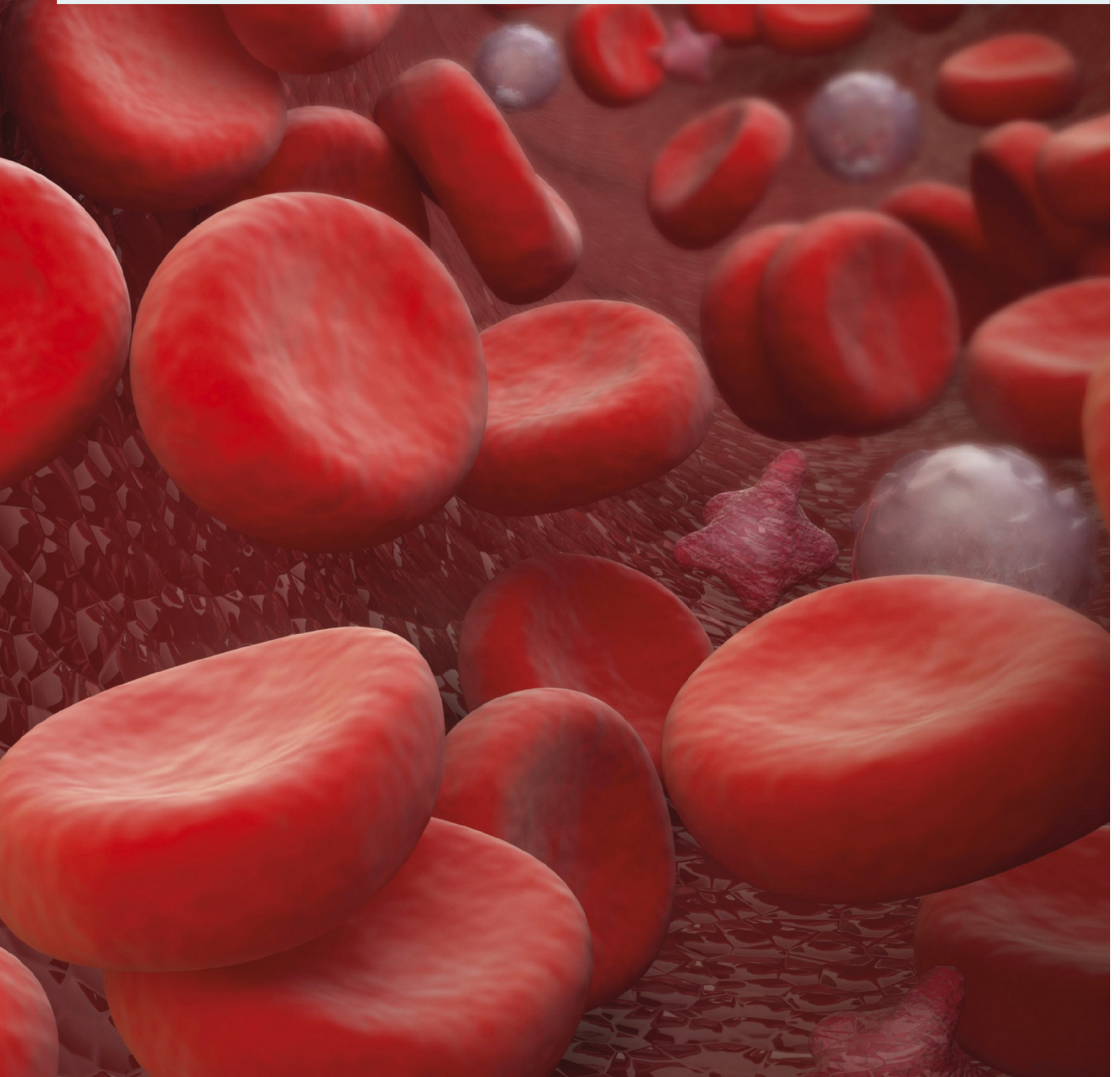
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This theme is called 'The circulatory system'. Blood flows around your body through blood vessels. You learned in unit 1 (Breathing and respiration) that the blood carries oxygen and carbon dioxide. Blood carries many other substances too, such as nutrients. Carrying substances around like that is also called 'transport'. Your heart pumps blood around. The path taken through the body by the blood is called the circulatory system. The kidneys purify your blood and produce urine. A doctor can often tell from the composition of your blood whether you are sick or healthy.

When you read the basics, you will come across the exercises as you go. You should do the exercises in your workbook.

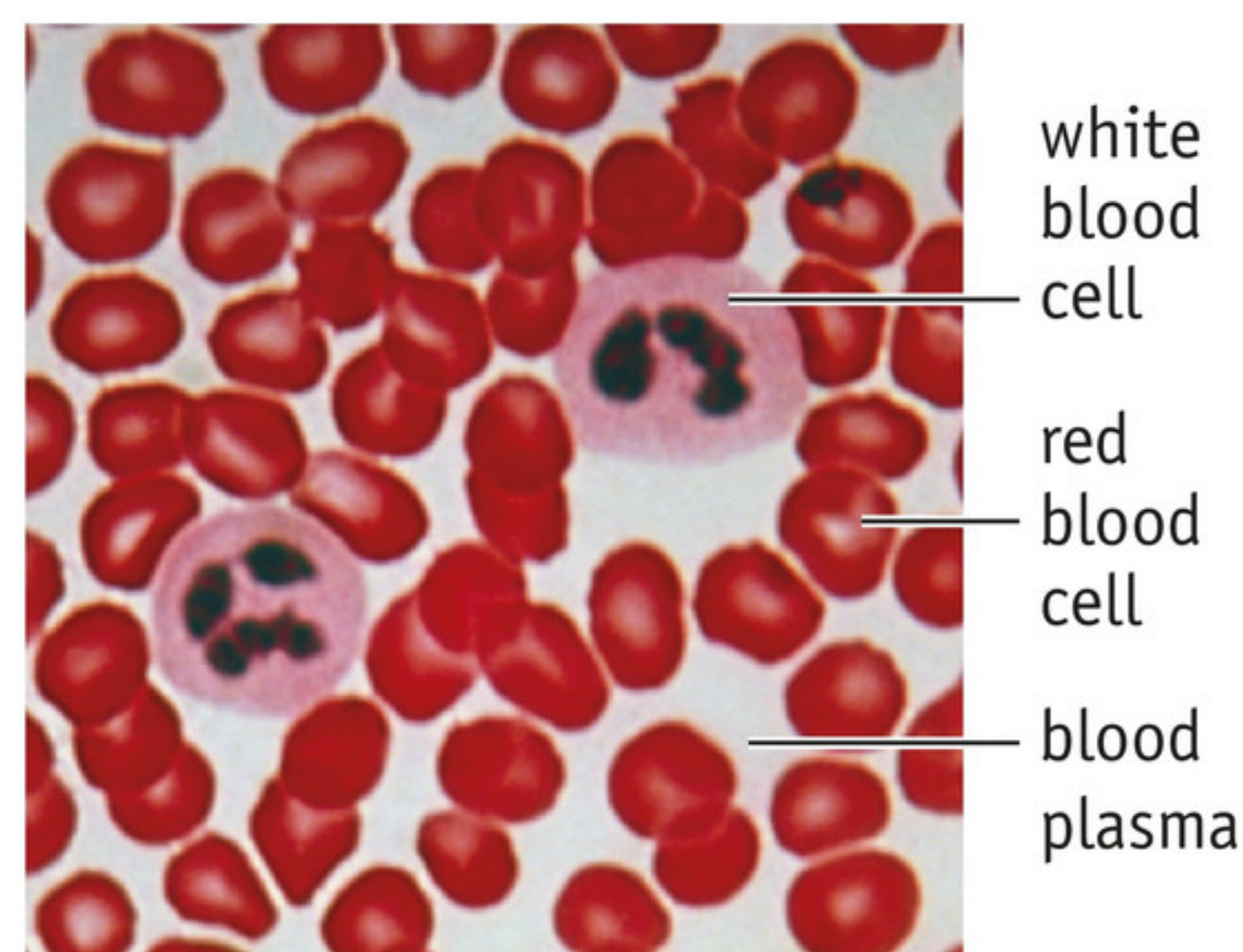
1 Blood

An adult human has five to six litres of blood. A liquid called **blood plasma** makes up 55% of the blood's volume. The other 45% consists of **red blood cells**, **white blood cells** and **platelets** (see figure 1).

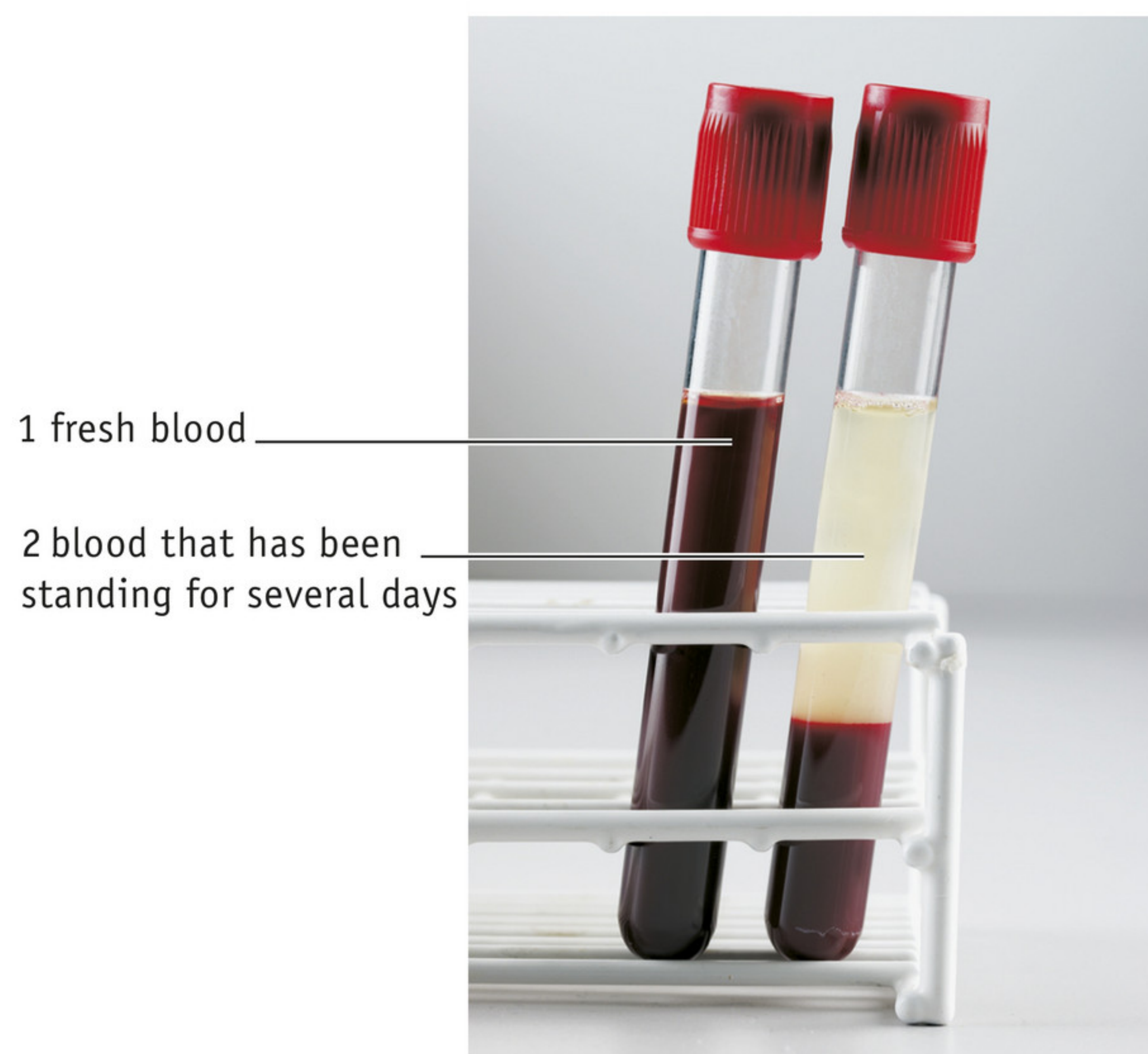
Figure 2 shows two test tubes with blood. Tube 1 contains fresh blood; tube 2 has been left standing for a few days. The blood cells and platelets have sunk to the bottom. On top of the blood cells and platelets is the blood plasma, which is yellow in colour.

The role of blood is to transport everything that the body needs to function, such as nutrients, oxygen, waste products and heat.

▼ **Fig. 1** Blood plasma and blood cells.



▼ **Fig. 2** Test tubes with blood.



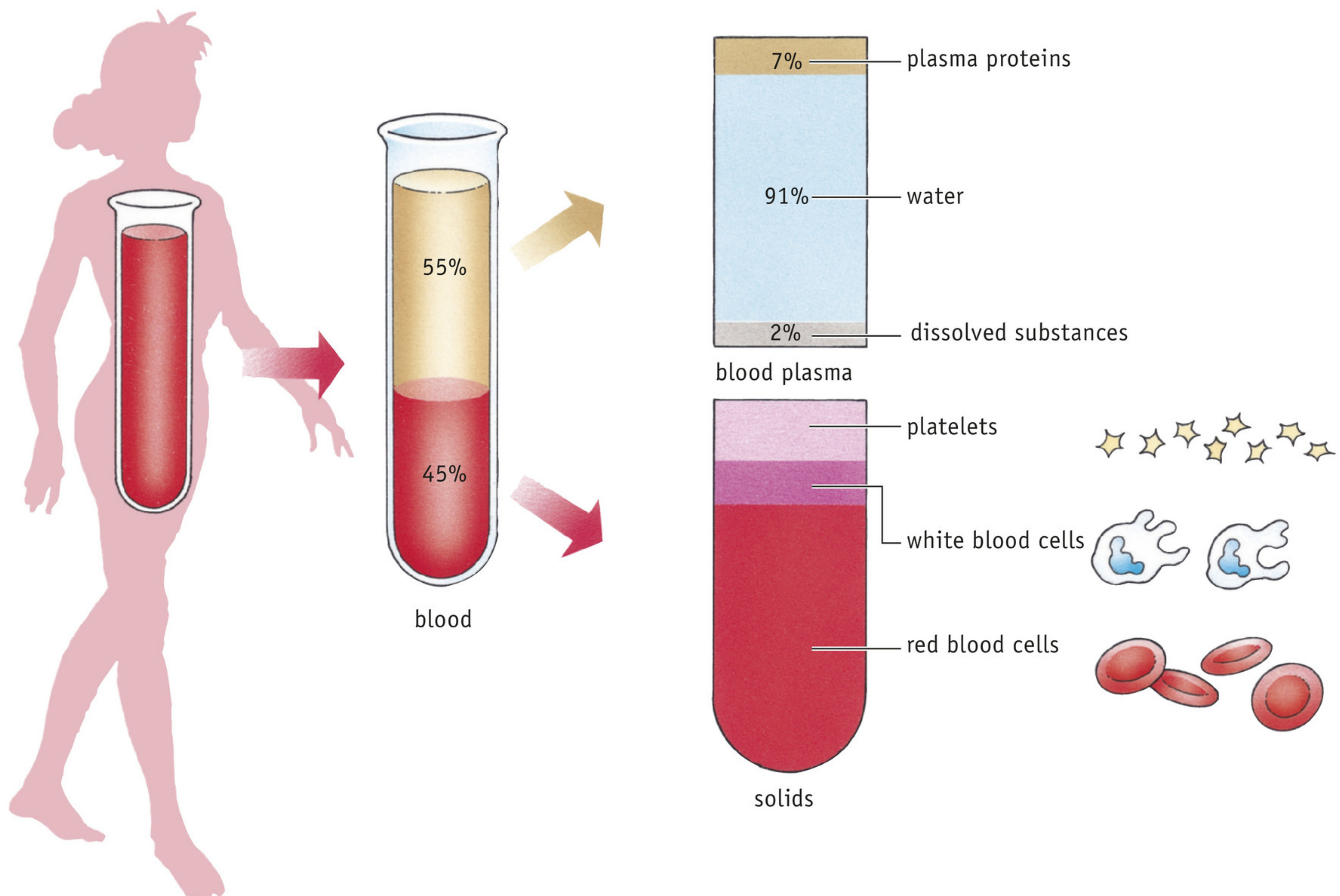
BLOOD PLASMA

Blood plasma consists of 7% **proteins** (plasma proteins) and 91% **water** (see figure 3). The remainder of the blood plasma consists of substances that have been dissolved in water (including **salts**).

One of the plasma proteins is **fibrinogen**. Fibrinogen plays a role in **clotting**. You can learn more about clotting in extension 2.

Blood plasma carries many substances, such as **oxygen** (a small amount), **nutrients**, **carbon dioxide** and other **waste products**.

▼ **Fig. 3** The composition of blood.



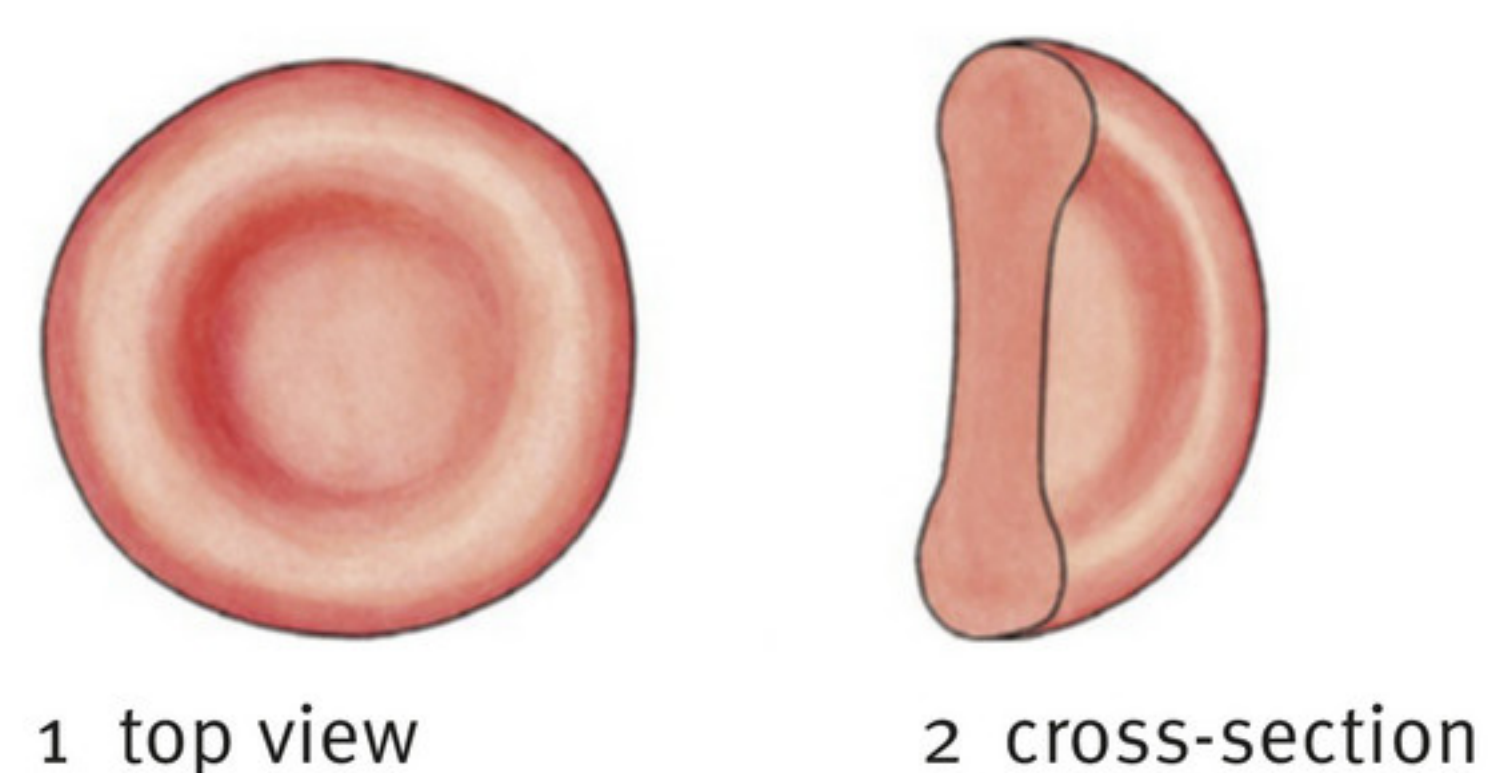
▼ **Fig. 4** Red blood cells (10,000× magnification).



RED BLOOD CELLS

Red blood cells are shaped like small, round discs (see figure 4). They are a bit thinner at the centre than the outer edges (see figure 5). Red blood cells do not have a nucleus. One cubic millimetre of blood contains an average of 5,000,000 red blood cells.

▼ **Fig. 5** A red blood cell.



Red blood cells are primarily for carrying oxygen. They contain a red pigment called **haemoglobin**. Haemoglobin allows red blood cells to absorb and release oxygen easily. Red blood cells absorb oxygen in the lungs and release it in other organs. A lack of haemoglobin can make you get very tired (see figure 6).

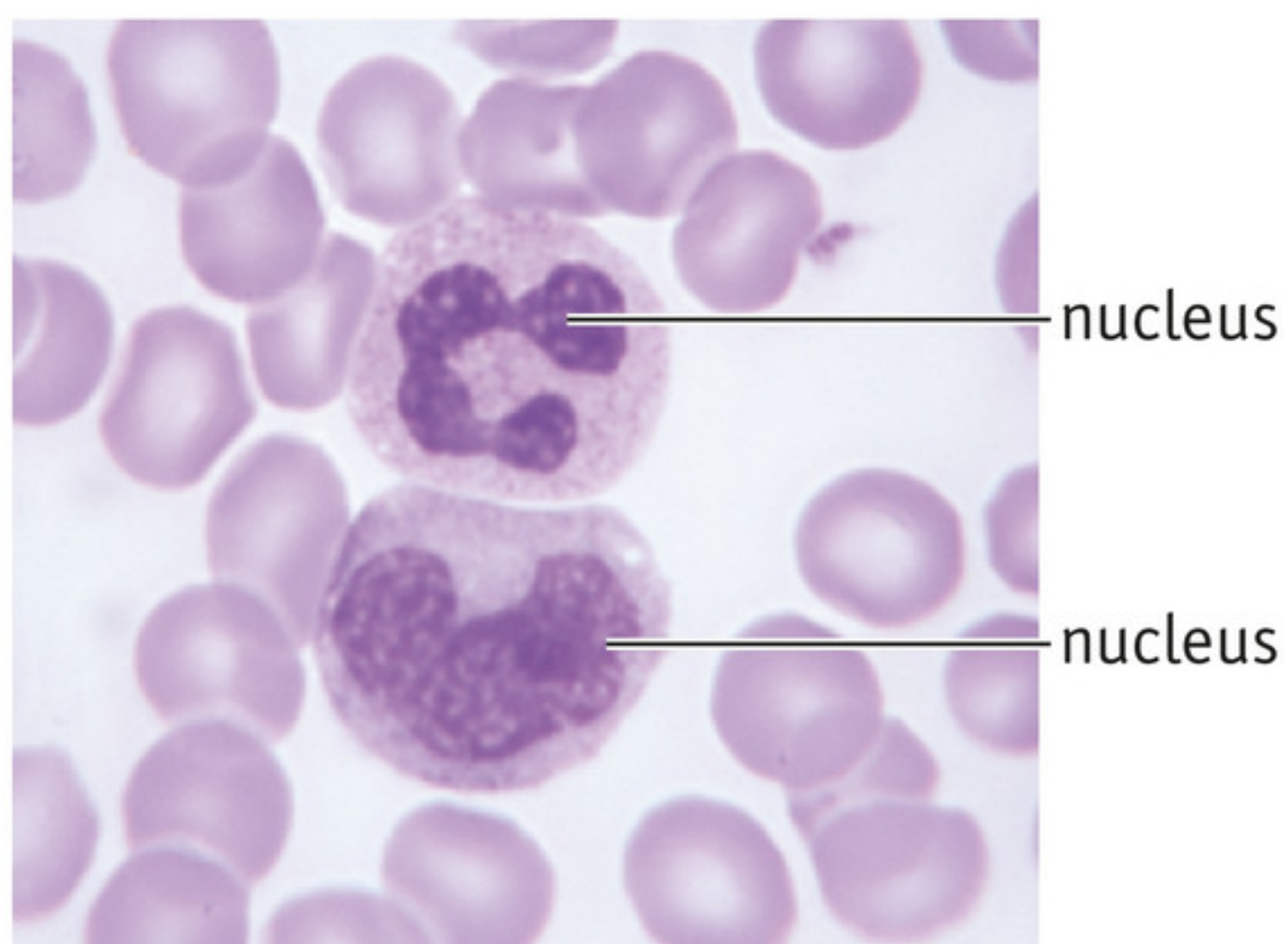
▼ Fig. 6

Sophie

Hello, I'm Sophie and I'm 13 years old. I often felt very tired, had headaches and was short of breath. I fainted a couple of times during ballet too. When I fainted at school as well, I went to see my GP. At first, the doctor thought I might have diabetes. A finger prick blood test let them measure my blood sugar level straight away, using a blood glucose meter (see the figure). My blood glucose level was not too high. So fortunately I'm not diabetic! My blood was examined in more detail at the hospital. We got the result three days later. I did not have enough of the red pigment (haemoglobin) or enough iron. After they had given me some pills, I fortunately soon started getting better.



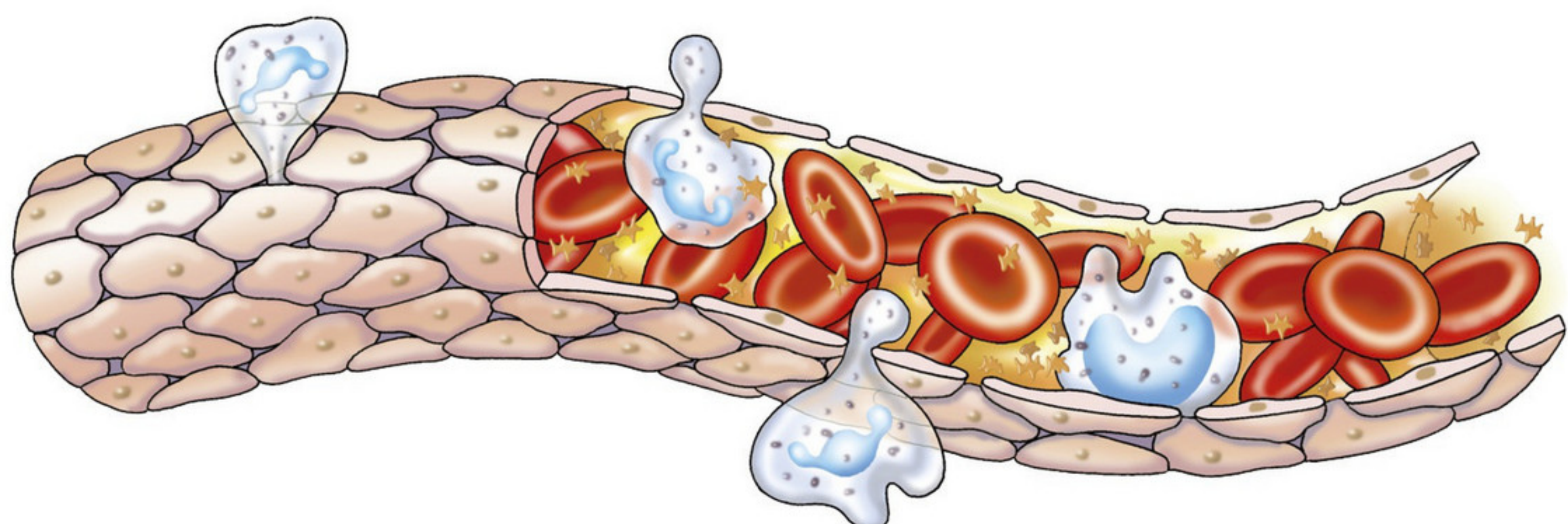
▼ Fig. 7 White blood cells (stained, 6000× magnification).



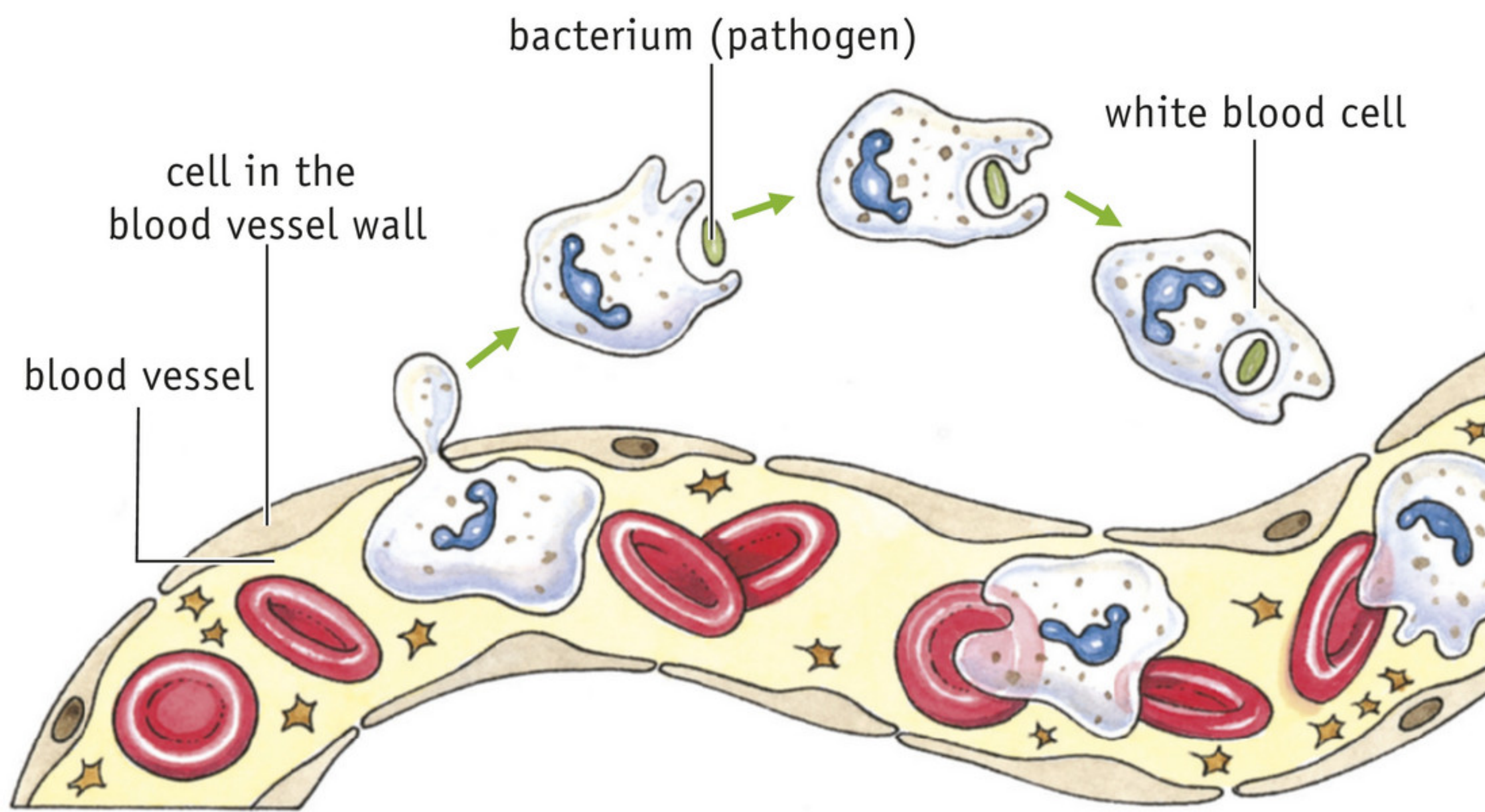
WHITE BLOOD CELLS

White blood cells do have a nucleus (see figure 7). These cells are made in the bone marrow. They do not have a fixed shape, which lets them pass through small openings in the smallest blood vessels (see figure 8). White blood cells destroy pathogens (germs such as bacteria). One particular type of white blood cell does that by engulfing and digesting pathogens (see figure 9). This usually kills the white blood cell in the process. This happens for example if a wound becomes infected (see figure 10). The **pus** in a wound consists of dead white blood cells and the bacteria they killed. Other types of white blood cells fight pathogens in other ways. You will learn more about that in basics 7. One cubic millimetre of blood contains an average of 7,000 white blood cells.

▼ Fig. 8 White blood cells can squeeze through openings in the walls of the smallest blood vessels.



▼ **Fig. 9** White blood cells kill bacteria by enclosing and digesting them (diagram).



▼ **Fig. 10** An inflamed wound with pus.



PLATELETS

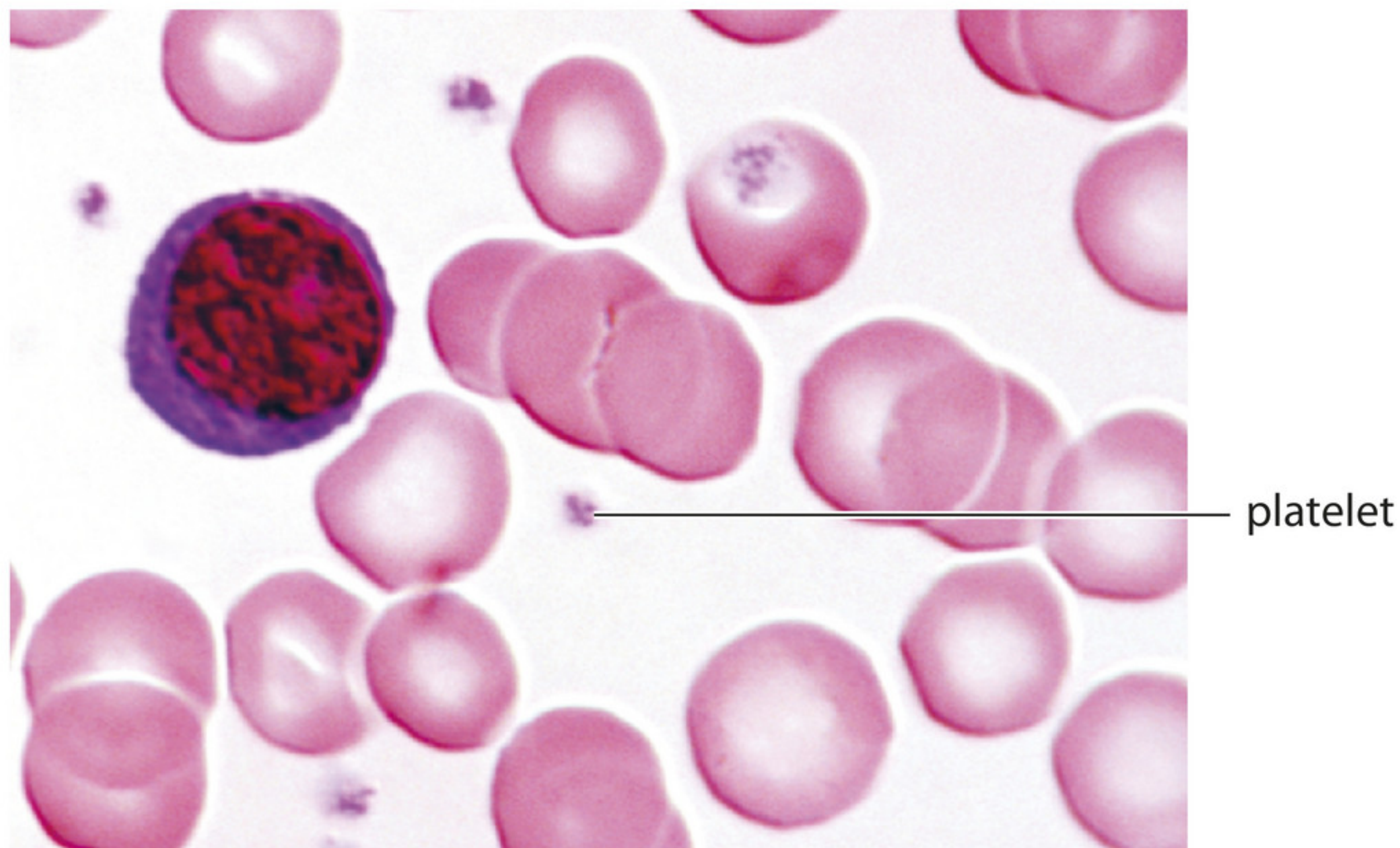
Platelets are not cells: they are fragments of cells that have broken up (see figure 11). They do not have a nucleus. One cubic millimetre of blood contains an average of 300,000 platelets.

Platelets are important in **clotting**. They contain substances that make sure that blood solidifies when it is outside the blood vessels (see figure 12). Blood plasma has a role in clotting too. You can learn more about this in extension 2.

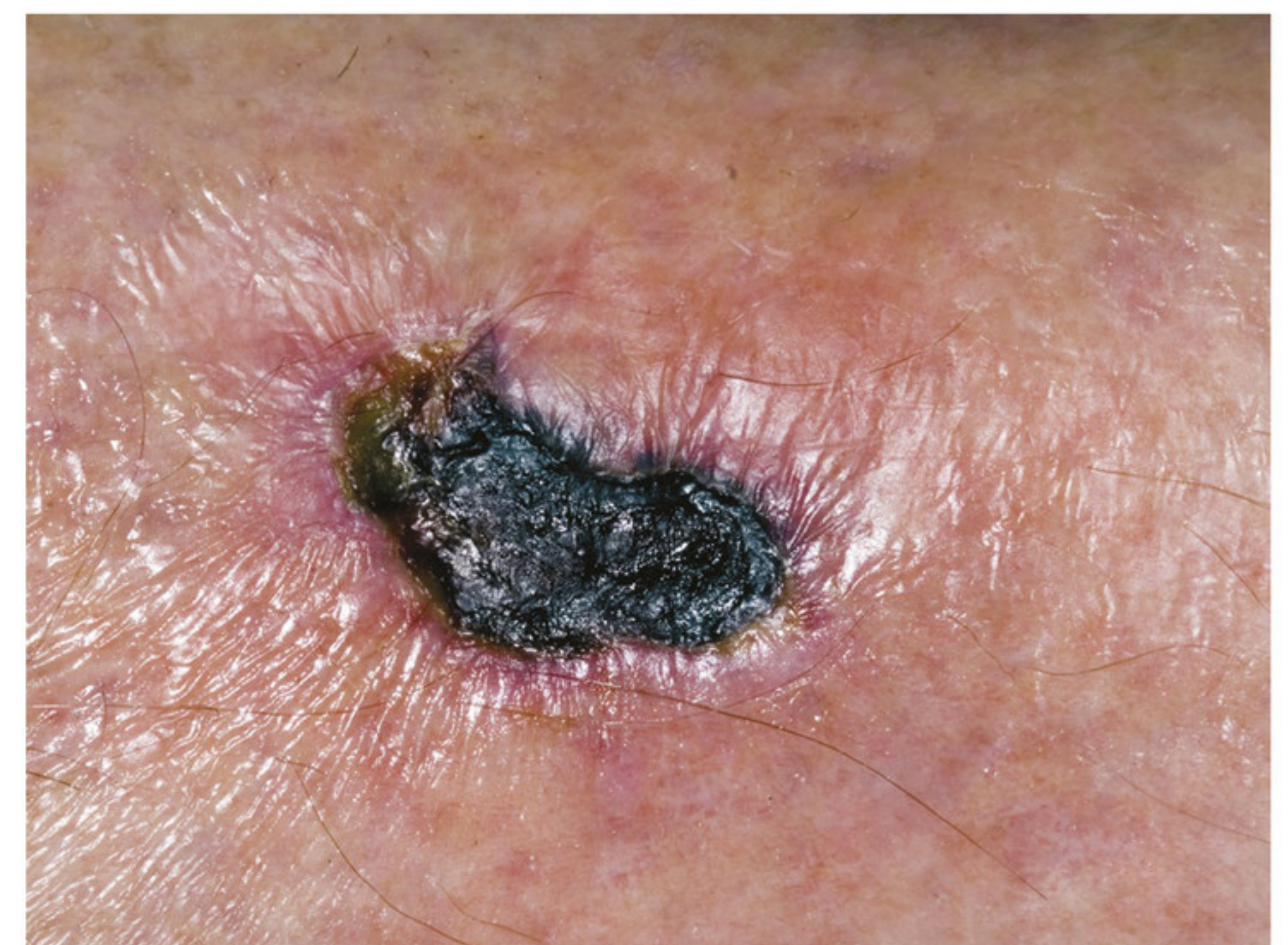
Sometimes blood can also clot inside the blood vessels. This then creates a blood clot or thrombus in a blood vessel. This is called **thrombosis**. Sometimes such a clot can obstruct a blood vessel, blocking the flow of blood.

WB EXERCISES 1 TO 7, PAGE 96

▼ **Fig. 11** Platelets.



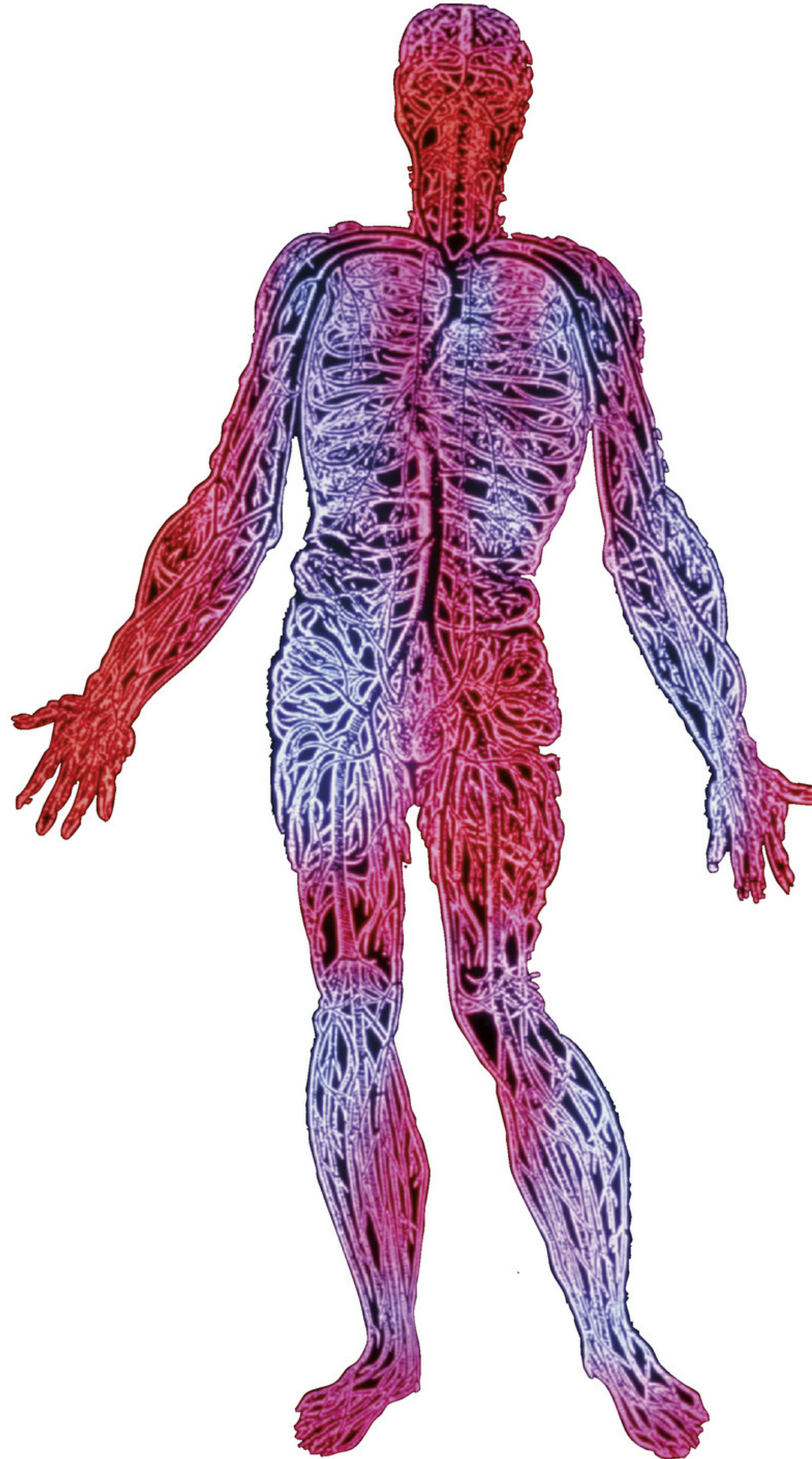
▼ **Fig. 12** When there is a wound, substances from the blood plasma and platelets make the blood clot.



2 Blood circulation

The human **circulatory system** consists of the **heart** and the **blood vessels**. There are large and small blood vessels throughout the body (see figure 13). The heart pumps blood through the blood vessels. The path taken through the body by the blood is called the **circulation**. During transport around the body, most of the blood remains inside the blood vessels. That is why it is called a **closed circulatory system**.

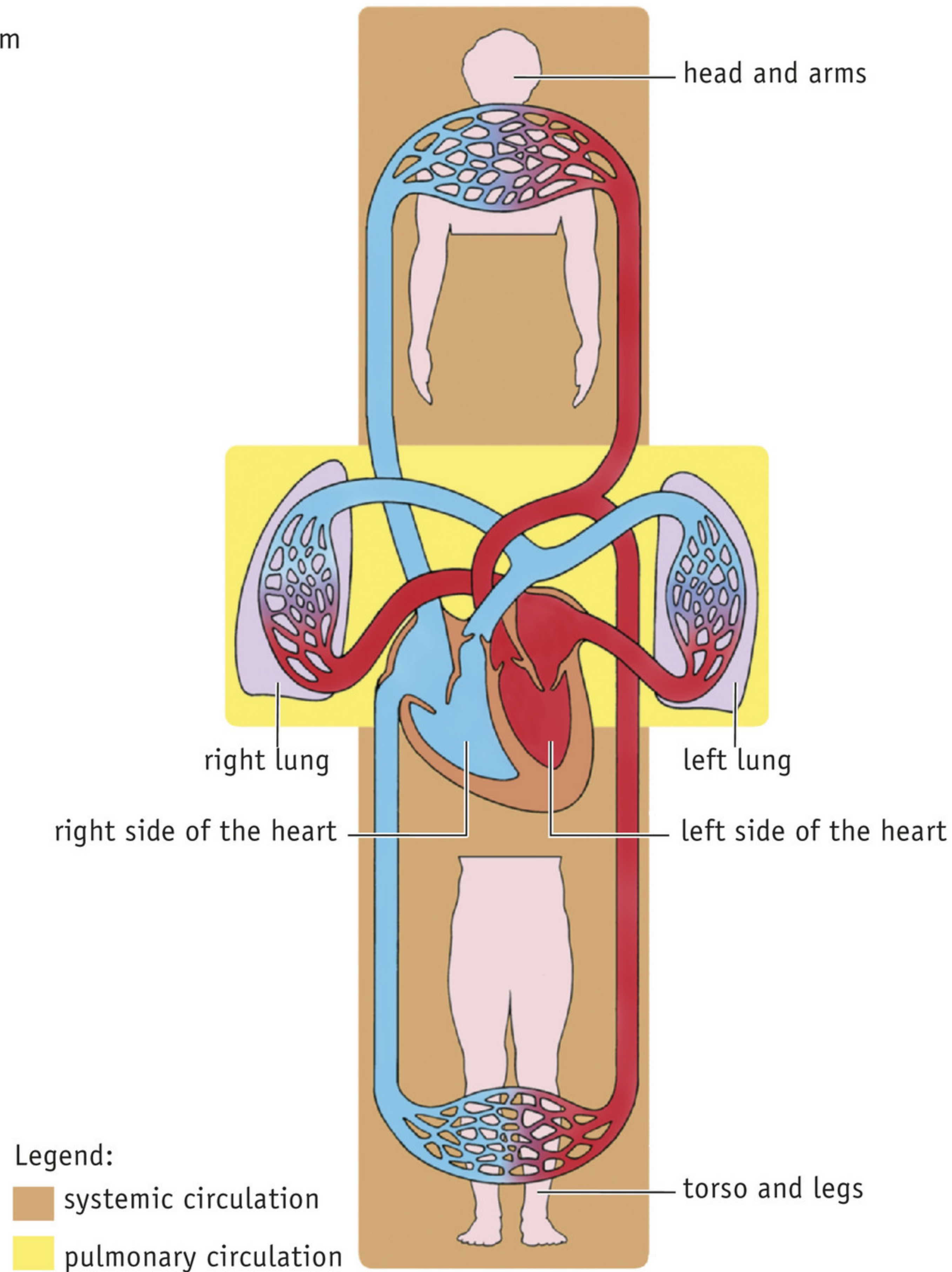
► **Fig. 13** Large and small blood vessels run everywhere through the body.



PULMONARY CIRCULATION

The heart is a double pump. The **right side of the heart** pumps the blood to the left and right lungs. From the lungs, the blood flows back to the heart. This part of the circulation is called the **pulmonary circulation** (see figure 14). In the pulmonary circulation, oxygen is absorbed into the bloodstream and carbon dioxide is released to the air. This happens in the lungs.

► **Fig. 14** The double circulatory system of a human (schematic).



SYSTEMIC CIRCULATION

Blood from the pulmonary circulation enters the **left side of the heart**. That side of the heart pumps the blood through organs throughout the whole body (see figure 14). From there the blood flows back to the right side of the heart. This part of the circulation is called the **systemic circulation**.

The systemic circulation carries oxygen and nutrients (including glucose) to the cells, while carbon dioxide and other waste products are absorbed into the bloodstream.

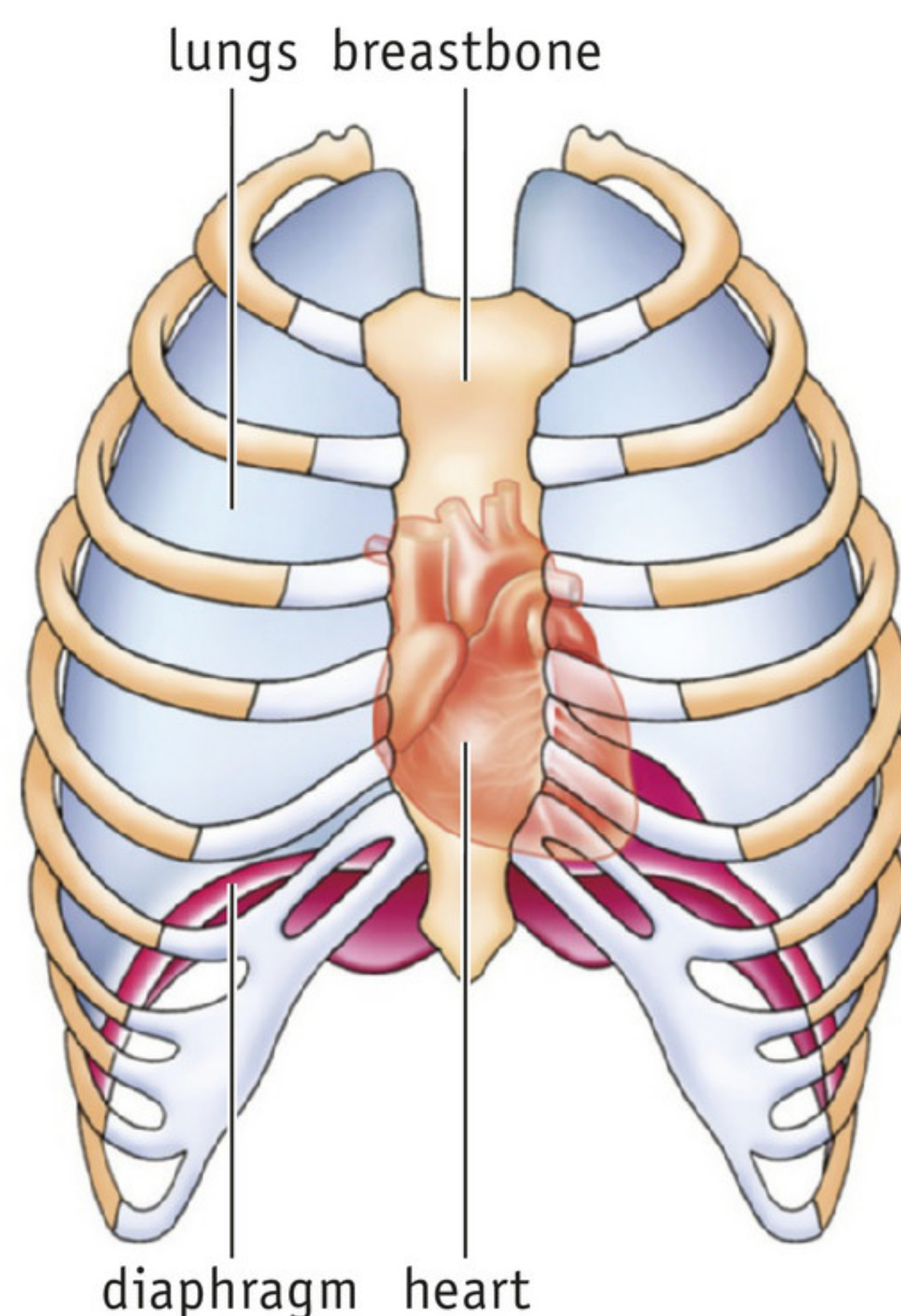
In each complete circuit, the blood passes through the heart twice. That is why it is called a **double circulatory system**.

WB EXERCISES 8 AND 9, PAGE 100

3 The heart

The heart is located inside the chest cavity, a little bit to the left at the bottom of the breastbone (see figure 15). Your heart is about the size of a fist.

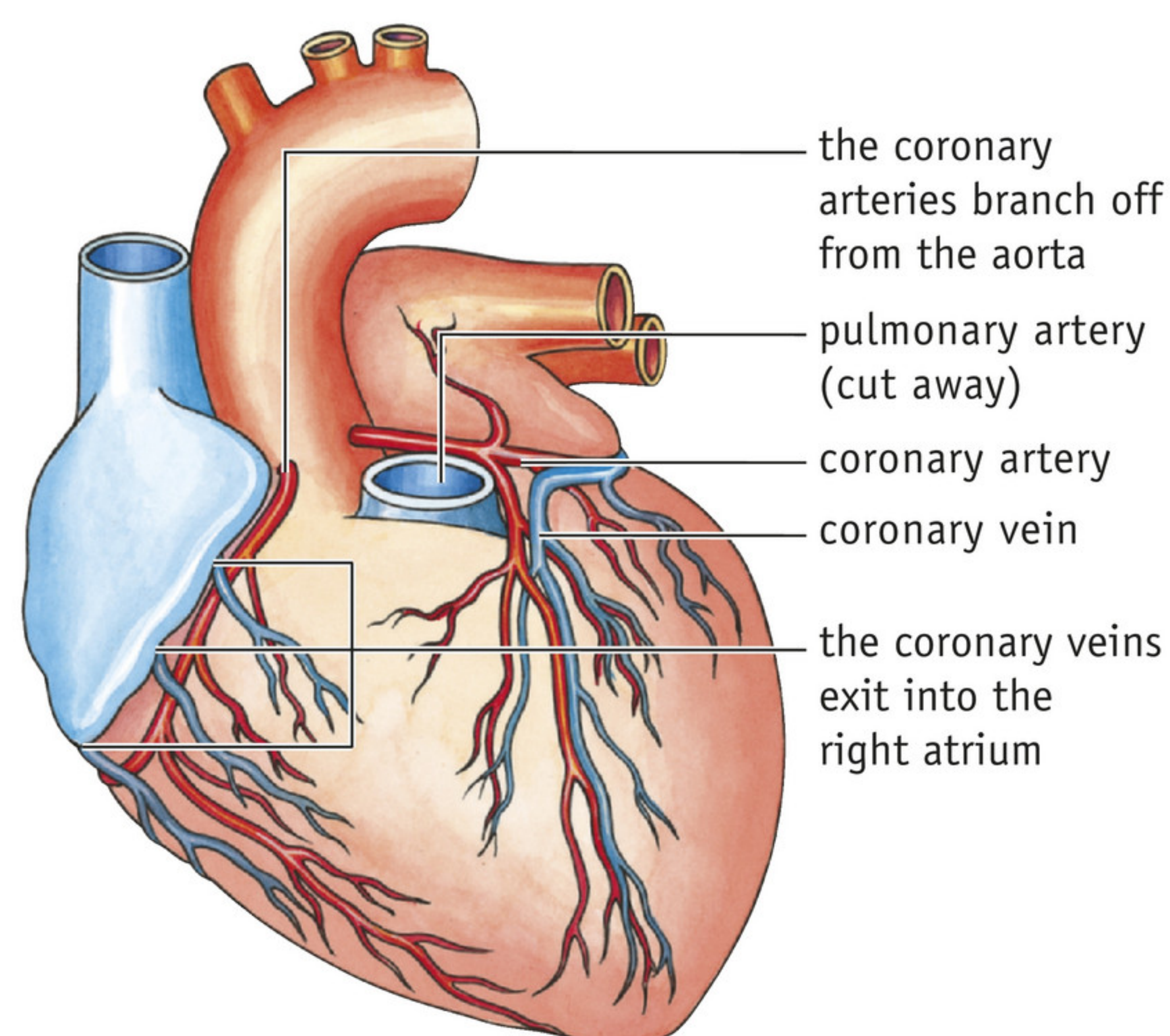
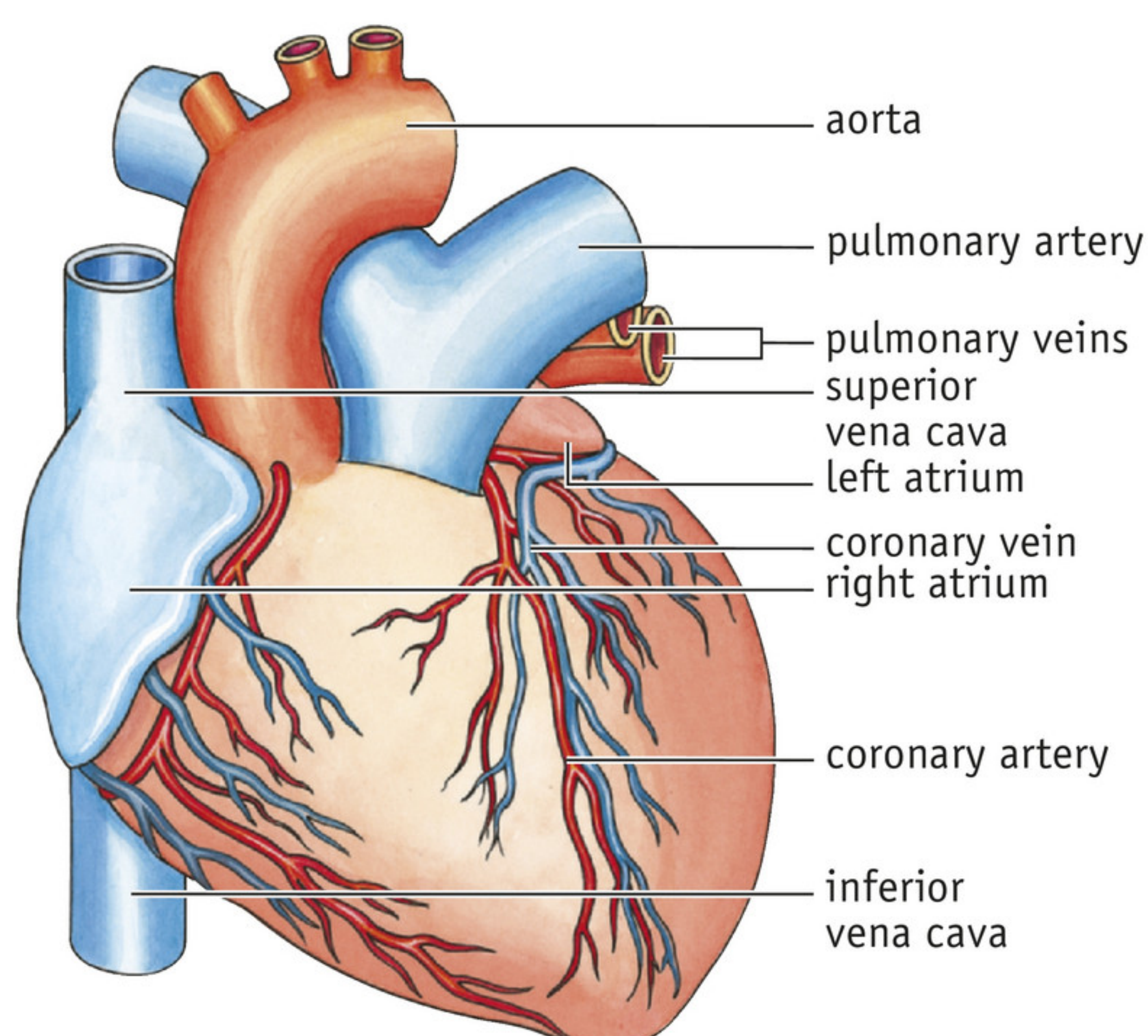
► **Fig. 15** Location of the heart (schematic).



THE STRUCTURE OF THE HEART

The heart is a hollow muscle. Coronary arteries and coronary veins run over the surface of the heart (see figure 16). The **coronary arteries** supply blood that is rich in oxygen and nutrients to the heart muscle. The coronary arteries branch off from the aorta (see figure 16.2). The **coronary veins** carry blood that is rich in carbon dioxide and other waste products away from the heart muscle.

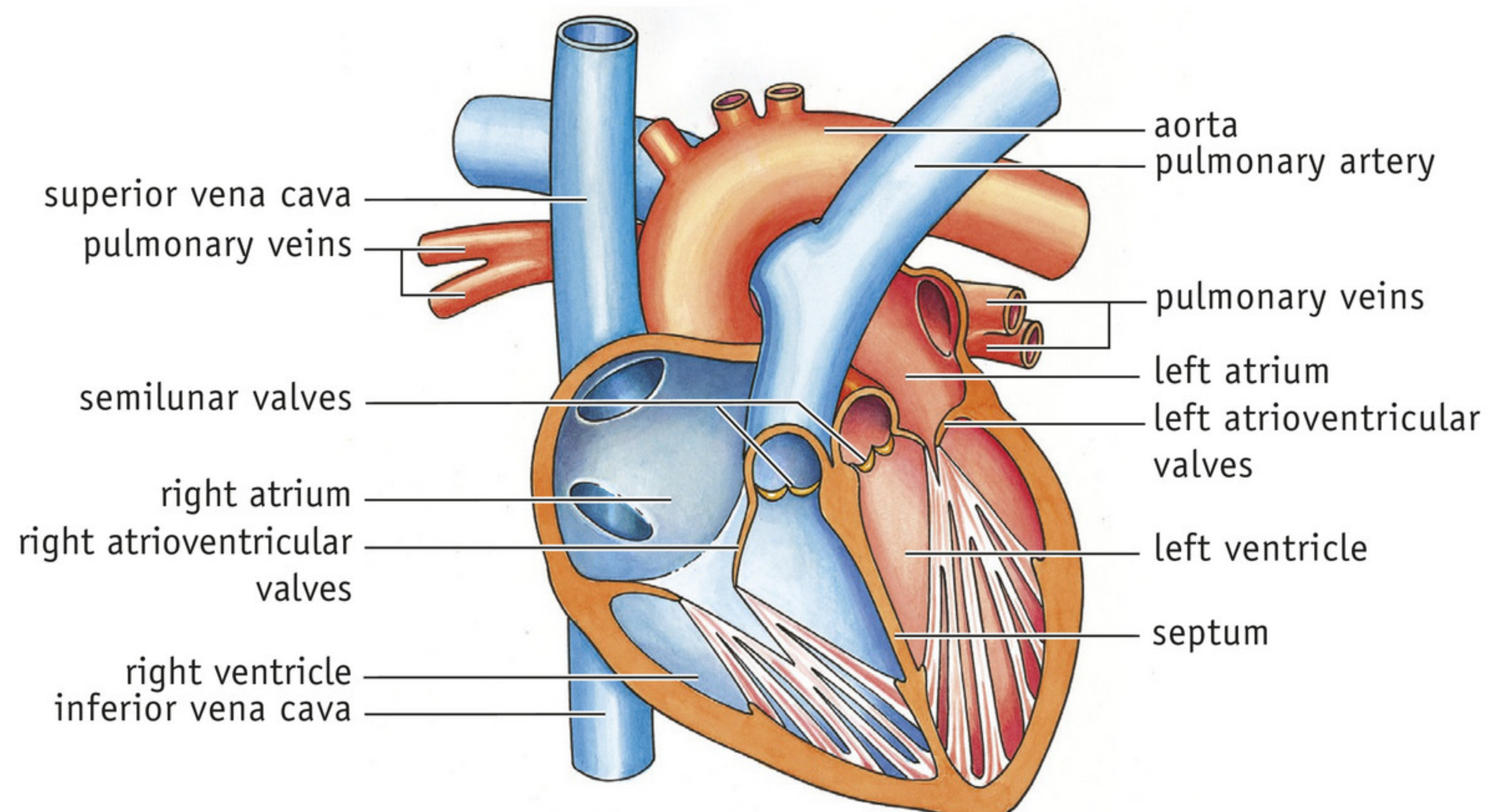
▼ **Fig. 16** The heart (external view).



The heart has two atria and two ventricles (see figure 17). The **septum** is a wall separating the left and right sides of the heart.

The oxygen-poor or **deoxygenated blood** that comes from the organs in the head and arms enters the heart through the **superior vena cava**. The deoxygenated blood that comes from the organs in the torso and legs enters the heart through the **inferior vena cava**. Blood from both these main veins flows into the **right atrium**. From the right atrium, the blood flows to the **right ventricle**. The right ventricle pumps the blood into the **pulmonary arteries**. The blood is **oxygenated** in the lungs and flows back to the heart through the **pulmonary veins**. Blood from the pulmonary veins flows into the **left atrium**. From the left atrium, the blood flows to the **left ventricle**. The left ventricle pumps the blood through the **aorta** to all the body's organs, where it becomes deoxygenated. The blood flows back into the heart again through the two main veins.

► **Fig. 17** The heart (longitudinal section).



The atria and ventricles are separated by the **atrioventricular valves**. These keep the blood from flowing from the ventricles back into the atria (see figure 18).

► **Fig. 18** How the atrioventricular valves work (schematic).



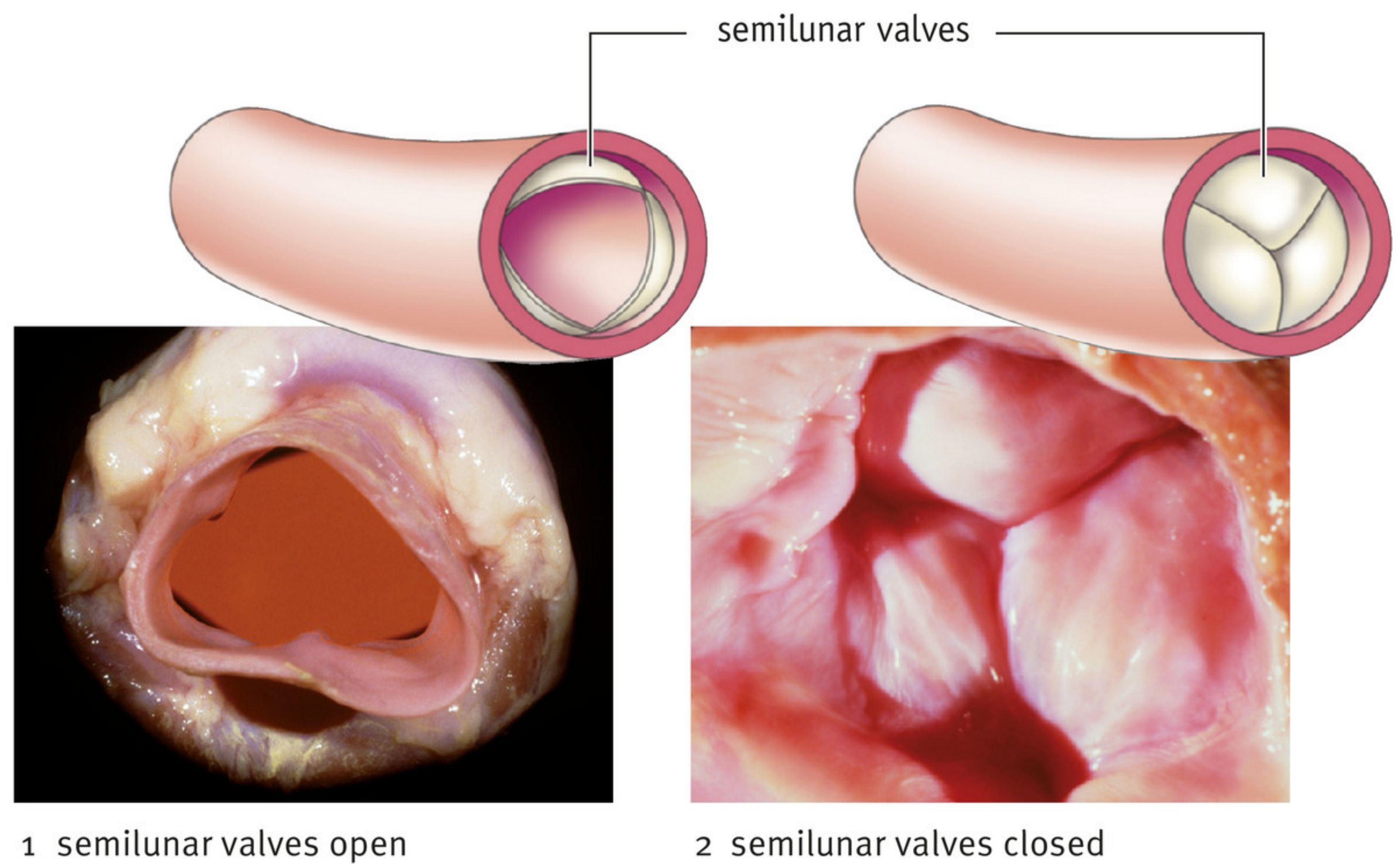
1 valves open: blood flows from the atria to the ventricles

2 valves closed: blood cannot flow back from the ventricles into the atria

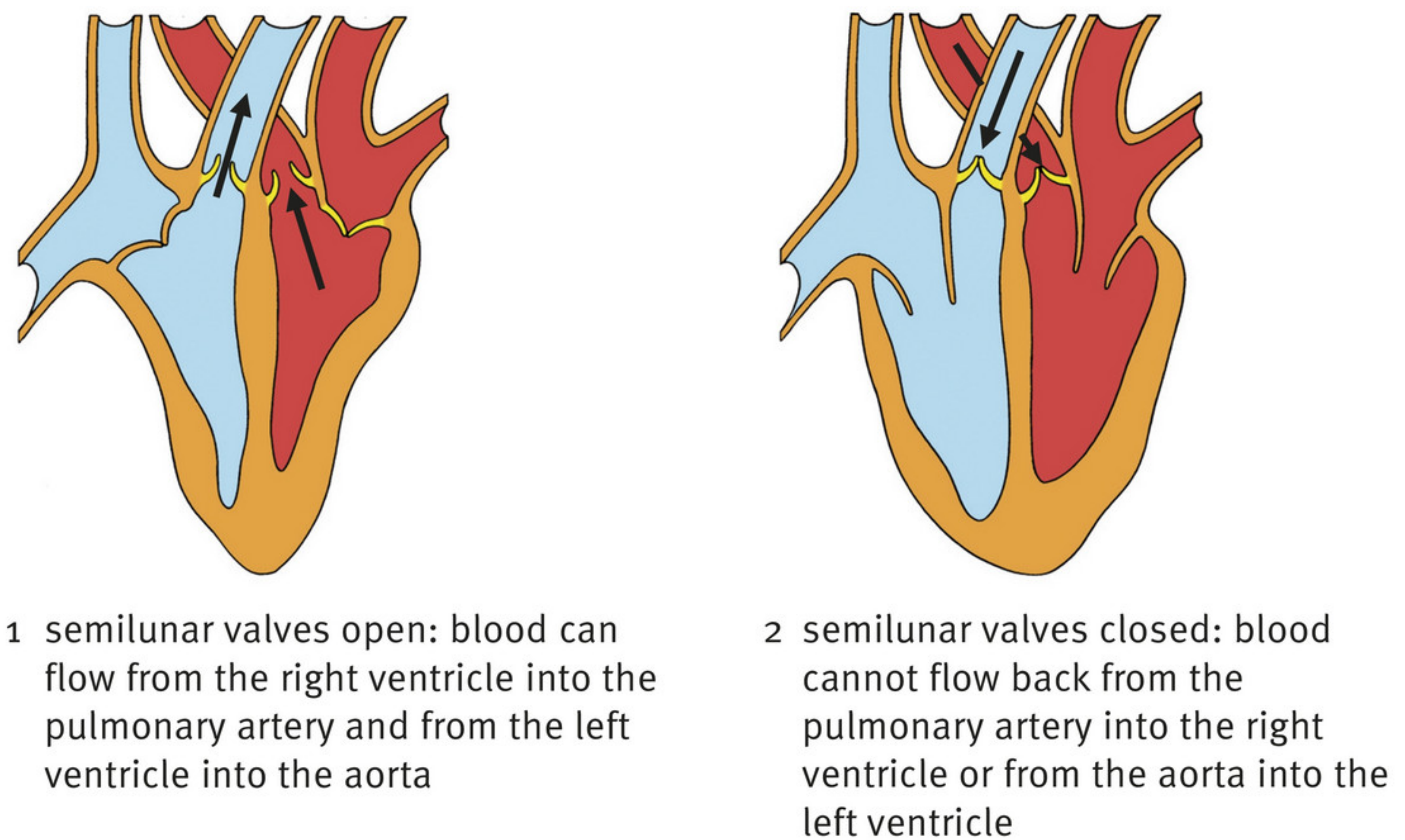
The **semilunar valves** are located at the start of the pulmonary artery and the aorta (see figure 19). These keep the blood from flowing back into the ventricles (see figure 20).

WB EXERCISES 10 TO 13, PAGE 102

► **Fig. 19** Semilunar valves in the aorta (schematic).



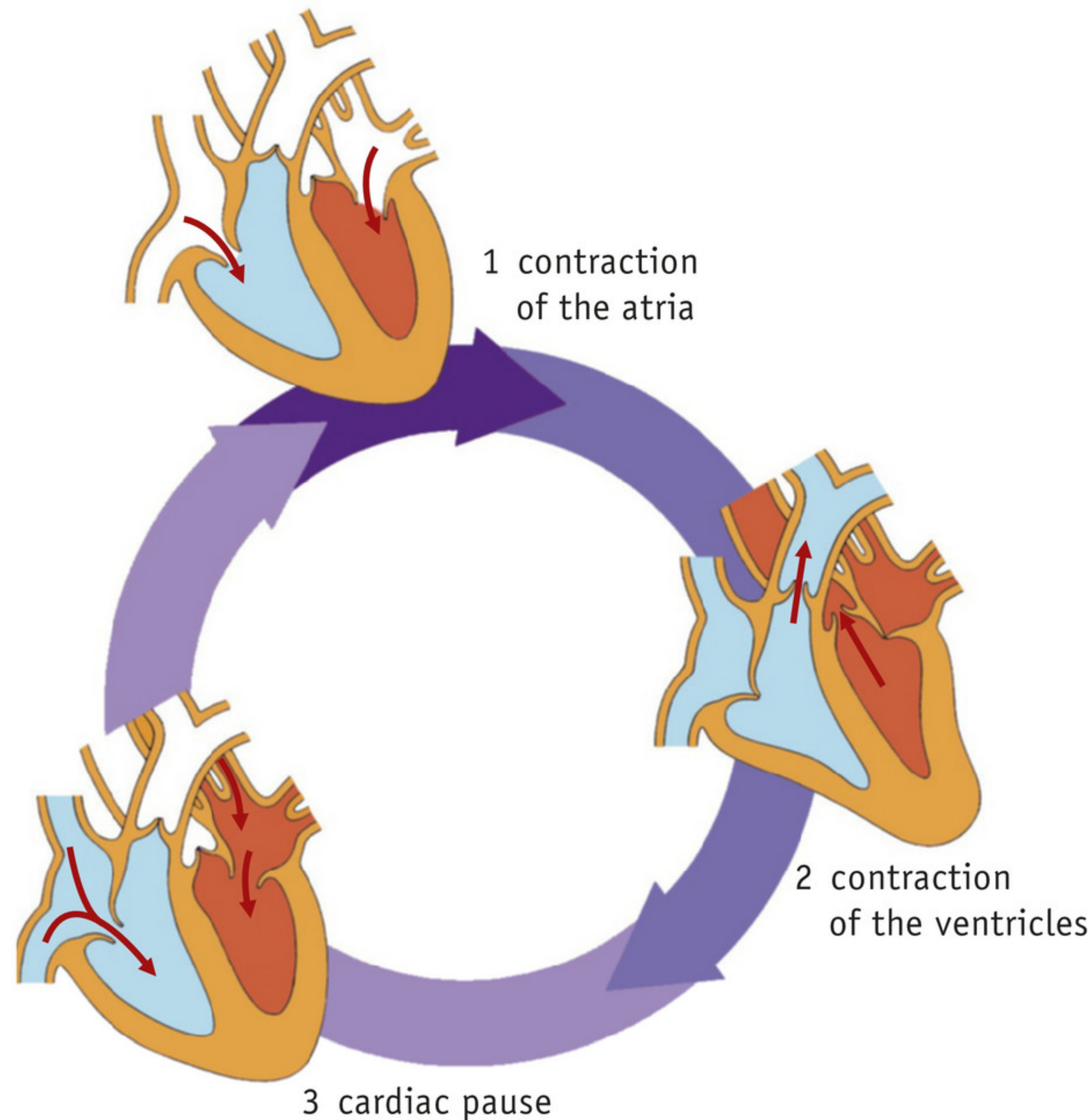
▼ **Fig. 20** How the semilunar valves work (schematic).



THE CARDIAC CYCLE

The heart muscle of an adult contracts on average 70 times a minute. We call that a **heart rate** of 70. You can hear the heartbeat because the valves make a noise as they close. There are three phases in the cardiac cycle (see figure 21). The heartbeat begins as the atria are filled with blood from the vena cava and

► **Fig. 21** The cardiac cycle (schematic).



the pulmonary veins. The **contraction of the atria** takes place at the same time on both sides of the heart. This makes blood flow into the ventricles (see figure 21.1). The ventricles are relaxed.

Once the ventricles have been filled with blood, the **contraction of the ventricles** takes place (see figure 21.2). The atrioventricular valves close and keep the blood from flowing back into the atria. The pressure in the ventricles increases. Once the pressure in the ventricles is higher than the pressure in the aorta and the pulmonary artery, the semilunar valves are pushed open. Blood is pumped simultaneously into the aorta and the pulmonary artery. During the contraction of the ventricles, the atria are relaxed.

This is followed by the **cardiac pause**. Both the ventricles and the atria are relaxed. The blood flows from the vena cava and pulmonary veins into the atria, and to some extent into the ventricles too (see figure 21.3). The semilunar valves are closed. This keeps the blood from the pulmonary artery and aorta from flowing back into the ventricles. This is then followed once again by contraction of the atria.

WB EXERCISES 14 TO 17, PAGE 104

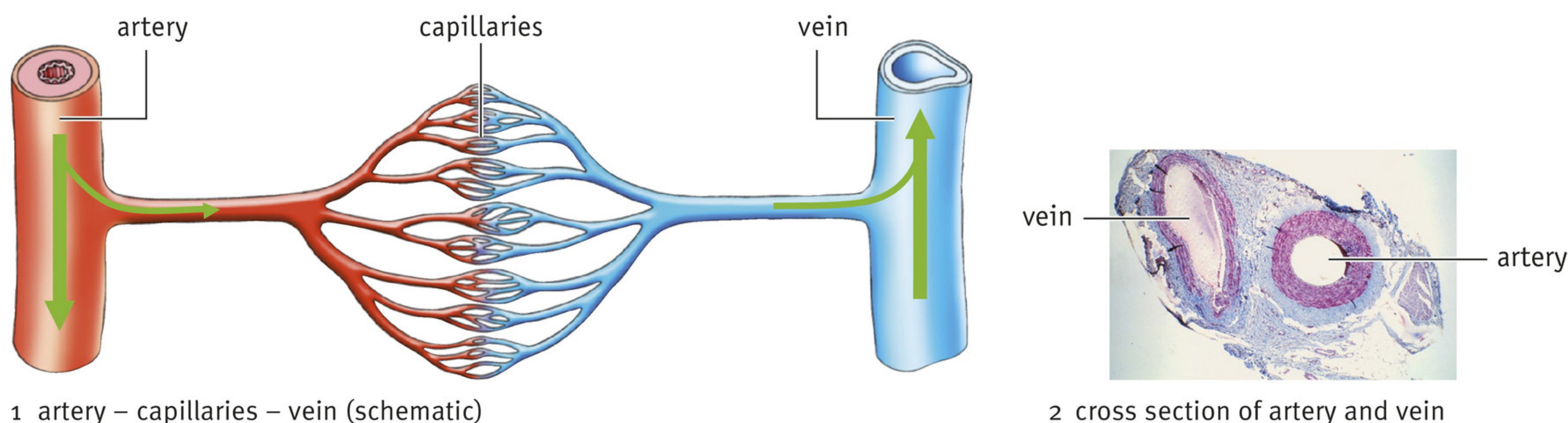
4 Blood vessels

There are three different types of blood vessels: arteries, capillaries and veins (see figure 22).

The heart pumps blood into the **arteries**. Blood flows forcefully through the arteries from the heart to the organs. The walls of arteries need to be thick, firm and elastic, because of the high **blood pressure** exerted on them.

When the heart pushes blood into the arteries, they expand. Afterwards they spring back into shape. You can feel this when you touch your wrist to feel your **pulse**. In the wrists, the arteries run just under the skin. Most arteries run deeper in the body, which makes it less easy for them to get damaged.

▼ **Fig. 22** Three types of blood vessels.



In the organs, the arteries branch out into smaller and smaller blood vessels (see figure 23). The walls of the blood vessels also get thinner. Blood vessels with walls that are only one cell layer thick are called **capillaries**. The capillaries in an organ form a **capillary network** (see figure 24).

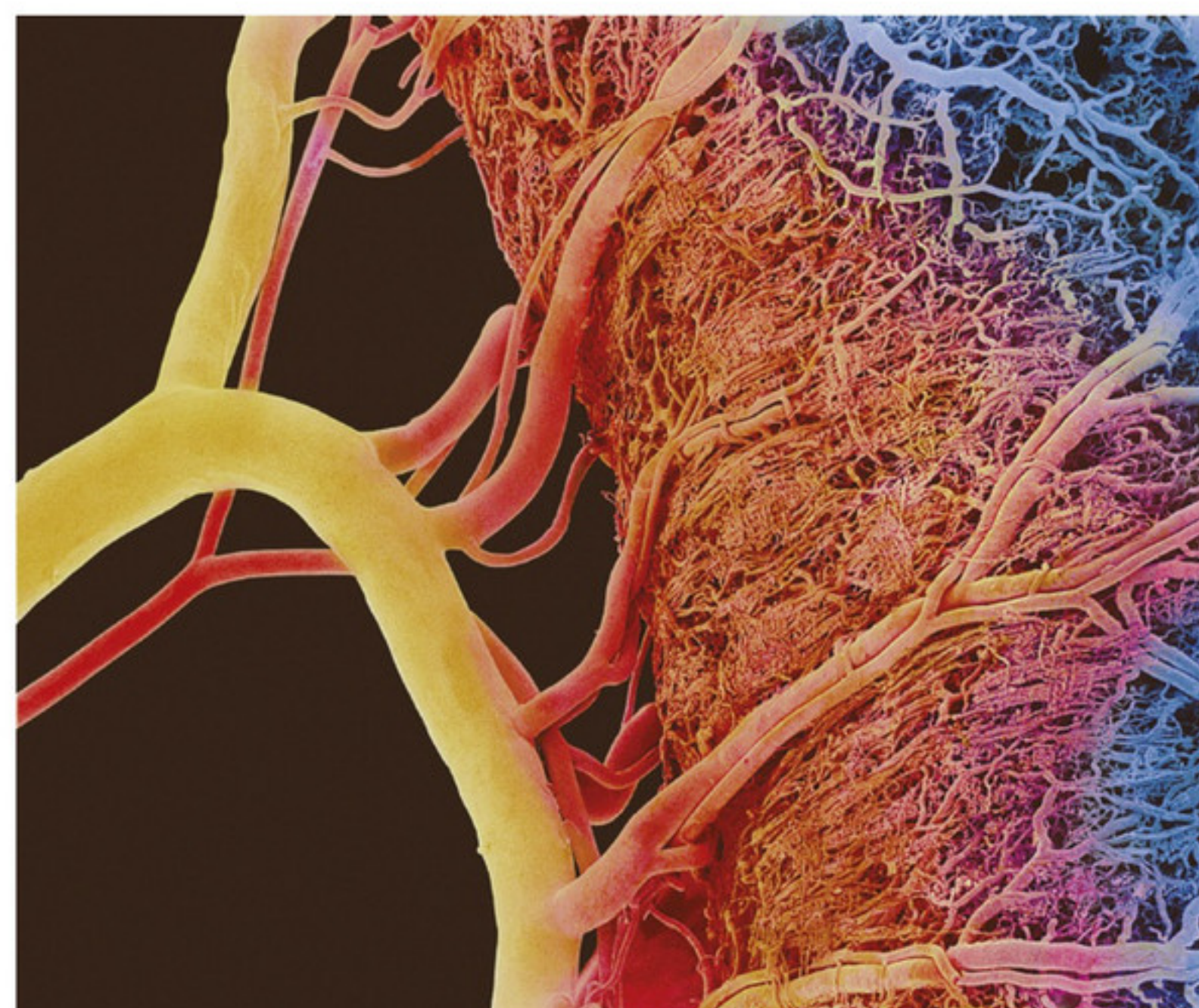
Blood pressure decreases dramatically in the capillaries. Fluids containing oxygen and nutrients can exit the capillaries into the cells through the thin walls of the capillaries. The cells use the oxygen and nutrients for respiration. This releases carbon dioxide and other waste products. Fluid containing carbon dioxide and other waste products can enter the capillaries through the thin walls.

The capillaries then converge into large blood vessels: the veins.

▼ **Fig. 23** Blood vessels in a hand.



▼ **Fig. 24** Capillary network.

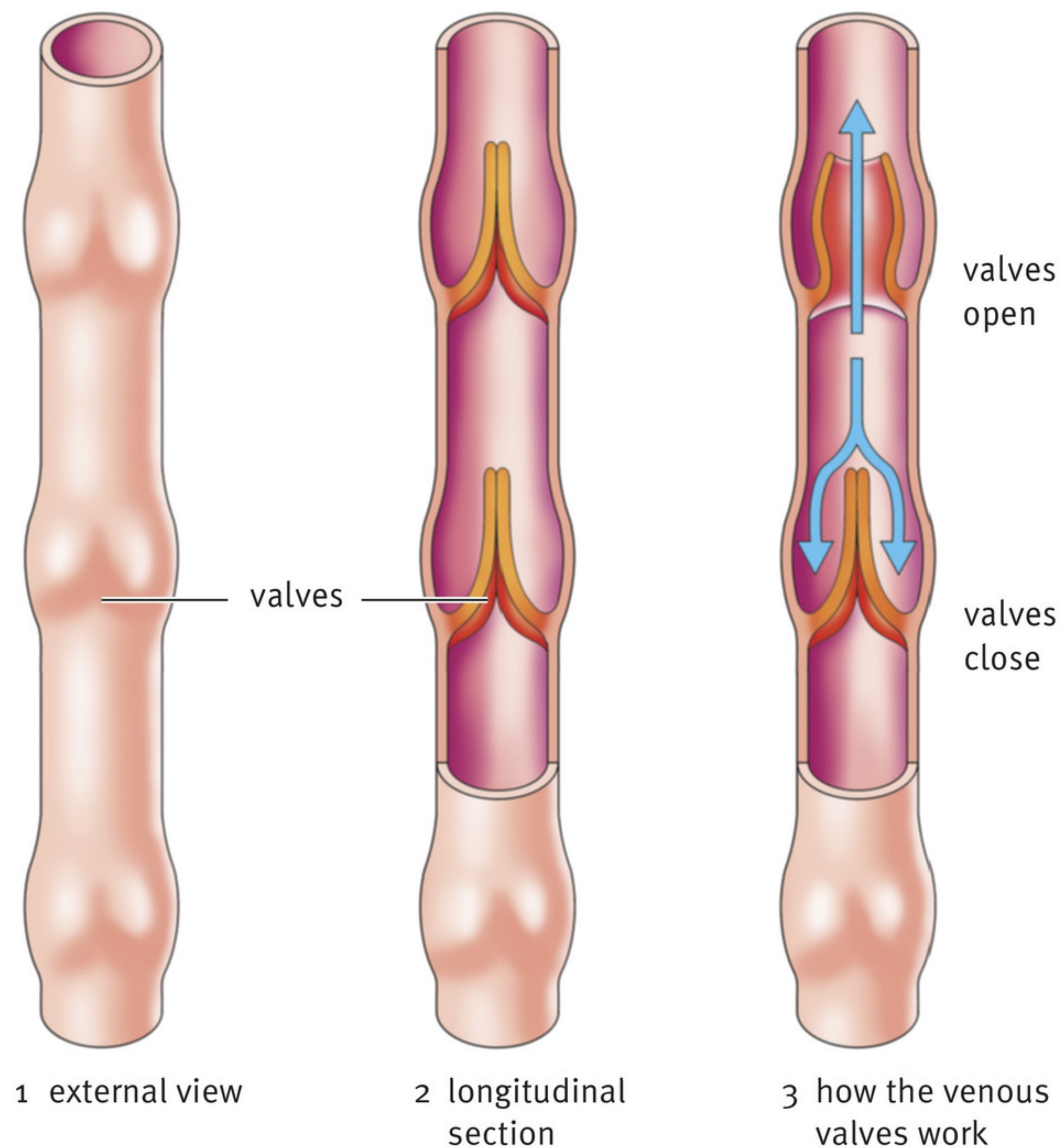


Blood flows through the **veins** from the organs back to the heart. The blood pressure in veins is low. The walls of veins are thinner and less elastic than those of arteries. There is no noticeable pulse in the veins. Veins generally run closer to the body's surface. You can often see them in your hands as bluish lines (see figure 23).

The heart draws blood back in from the veins. A lot of veins, especially in the arms and legs, have **valves**. These venous valves allow the blood to flow in one direction only (see figure 25). The valves help to carry the blood back to the heart. They prevent the blood from flowing back towards the organs. Arteries have no valves, except for the semilunar valves at the start of the pulmonary artery and the aorta.

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► **Fig. 25** Vein (diagram).

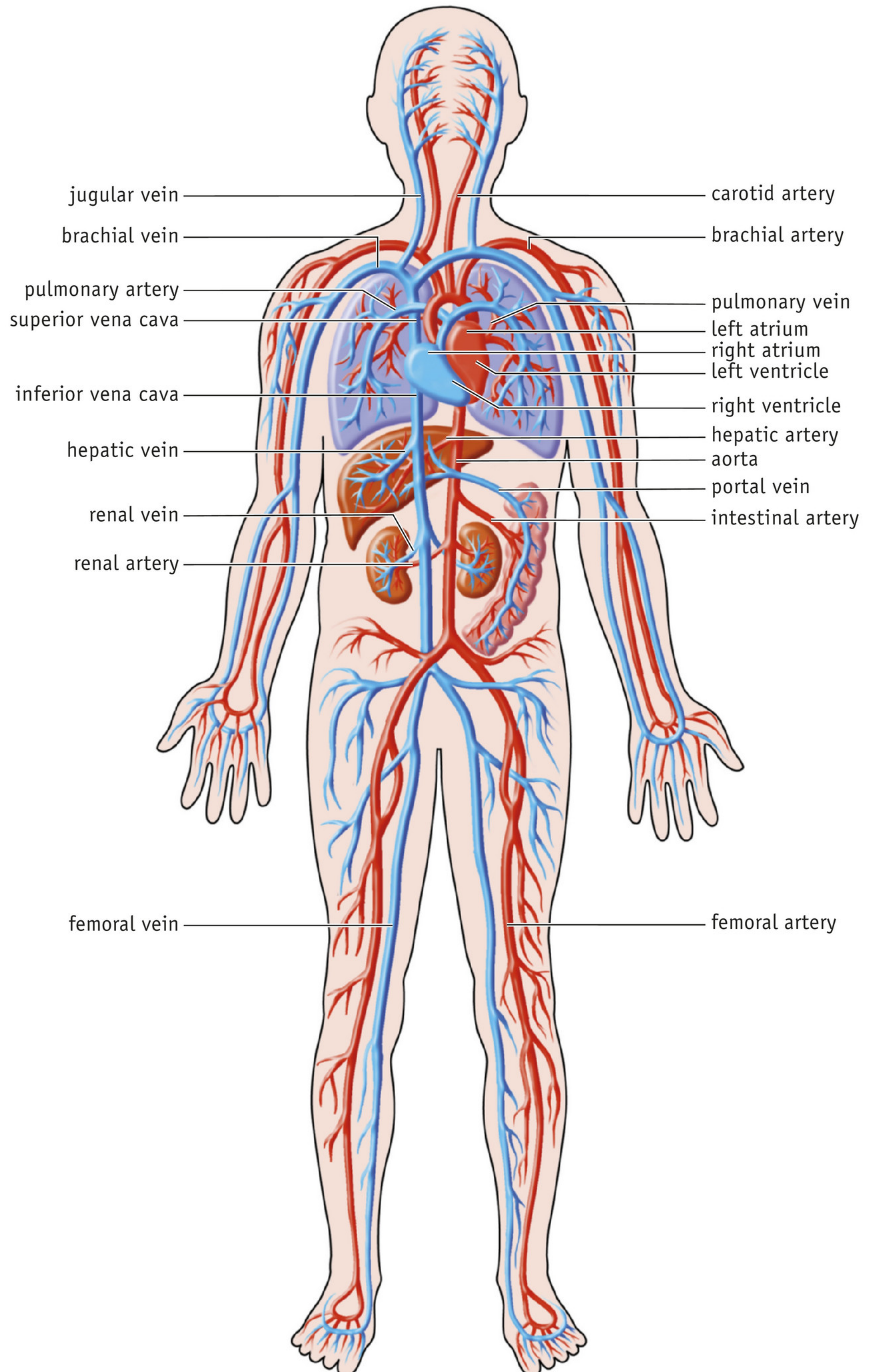


THE CIRCULATORY SYSTEM

All the blood vessels in your body form the **circulatory system**.

Figure 26 shows the key blood vessels of the circulatory system. The capillaries have been left out. The blood vessels coloured red contain oxygenated blood; the blue vessels contain deoxygenated blood.

► **Fig. 26** The circulatory system (schematic).



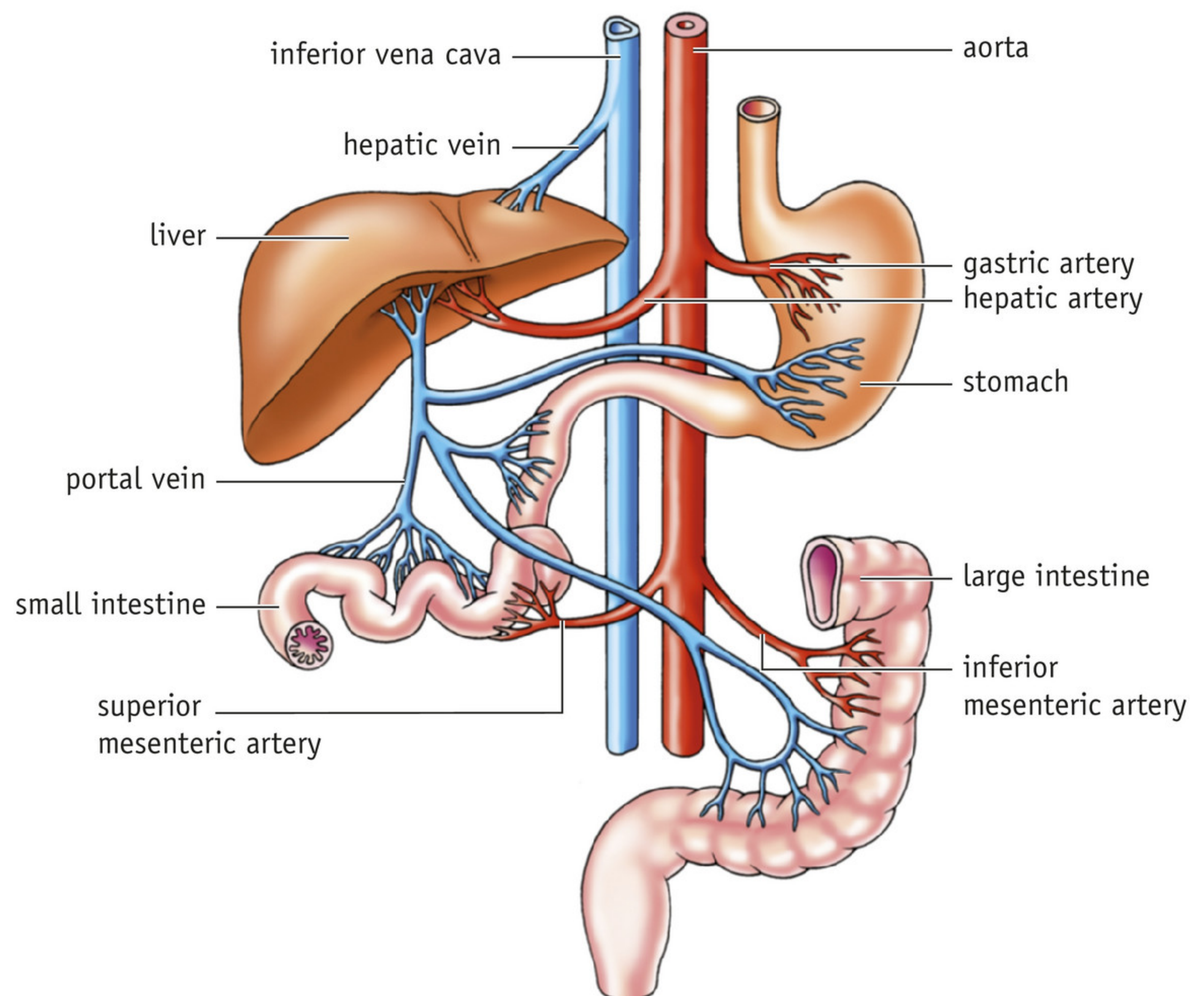
Arteries and veins generally are named after the organ they run to or from. For example, the renal arteries supply blood to the kidneys (the adjective 'renal' is from the Latin word for kidney); the renal veins carry blood away from the kidneys.

The blood flow away from the wall of the intestinal tract is an exception. The blood from much of the intestinal tract goes through the **portal vein** to the liver (see figure 27). This is deoxygenated blood: the intestinal tract has used the oxygen for respiration. The liver receives its own oxygenated blood through the **hepatic artery**. The blood exits the liver through the **hepatic vein**.

In unit 2 (Nutrition and digestion), you learned that the small intestine absorbs nutrients into the bloodstream. This means that the composition of the blood in the portal vein can vary considerably. The portal vein contains a lot of nutrients after a meal. A proportion of these nutrients are stored temporarily in the liver.

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► **Fig. 27** The portal vein with branches (schematic).



5 Cardiovascular diseases

Cardiovascular diseases are the collective term for conditions that affect the heart and circulatory system. They are one of the leading causes of death in the Netherlands (see figure 28). Many cardiovascular diseases are caused by high blood pressure and atherosclerosis.

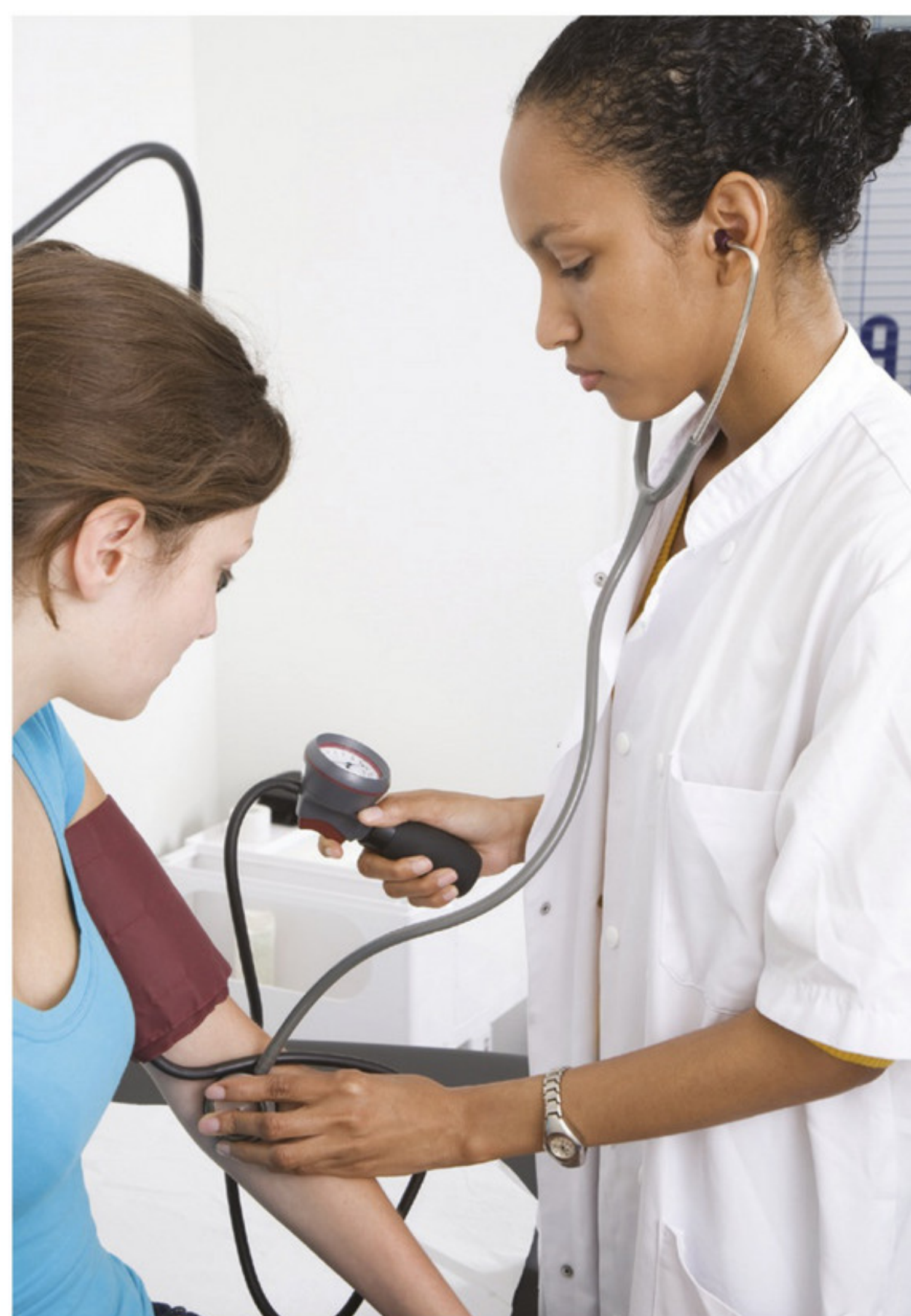
▼ Fig. 28

Cardiovascular diseases in the Netherlands

Cancer and cardiovascular diseases are the two key groups of diseases that people died from in the Netherlands in 2011. In 2011, 44,038 people died of cancer in the Netherlands and 38,132 of cardiovascular diseases. In addition, about 13,500 died of respiratory conditions and 40,231 of other causes. Of all the people who died in Europe, on average nearly half were as a consequence of a cardiovascular condition. According to the researchers, that percentage is somewhat lower in the Netherlands because more people who are at risk of cardiovascular diseases are identified earlier, for example, and the treatment of cardiovascular diseases has been improved. In 2012, people in Netherlands also turned out to have been living more healthily.



▼ Fig. 29 Blood pressure measurement.



HIGH BLOOD PRESSURE

Blood pressure is the pressure exerted on the arteries as the blood is pumped around. The blood pressure is measured with a sphygmomanometer (see figure 29). Some people have blood pressure problems. **Low blood pressure** is uncommon and it usually is a fairly harmless condition. People with low blood pressure tend to get headaches more often. They also complain about dizziness, especially immediately after getting up from a lying or sitting position. **High blood pressure** is more common. Research shows that high blood pressure affects life expectancy (see figure 30). Long-term high blood pressure damages the artery walls. This can trigger atherosclerosis.

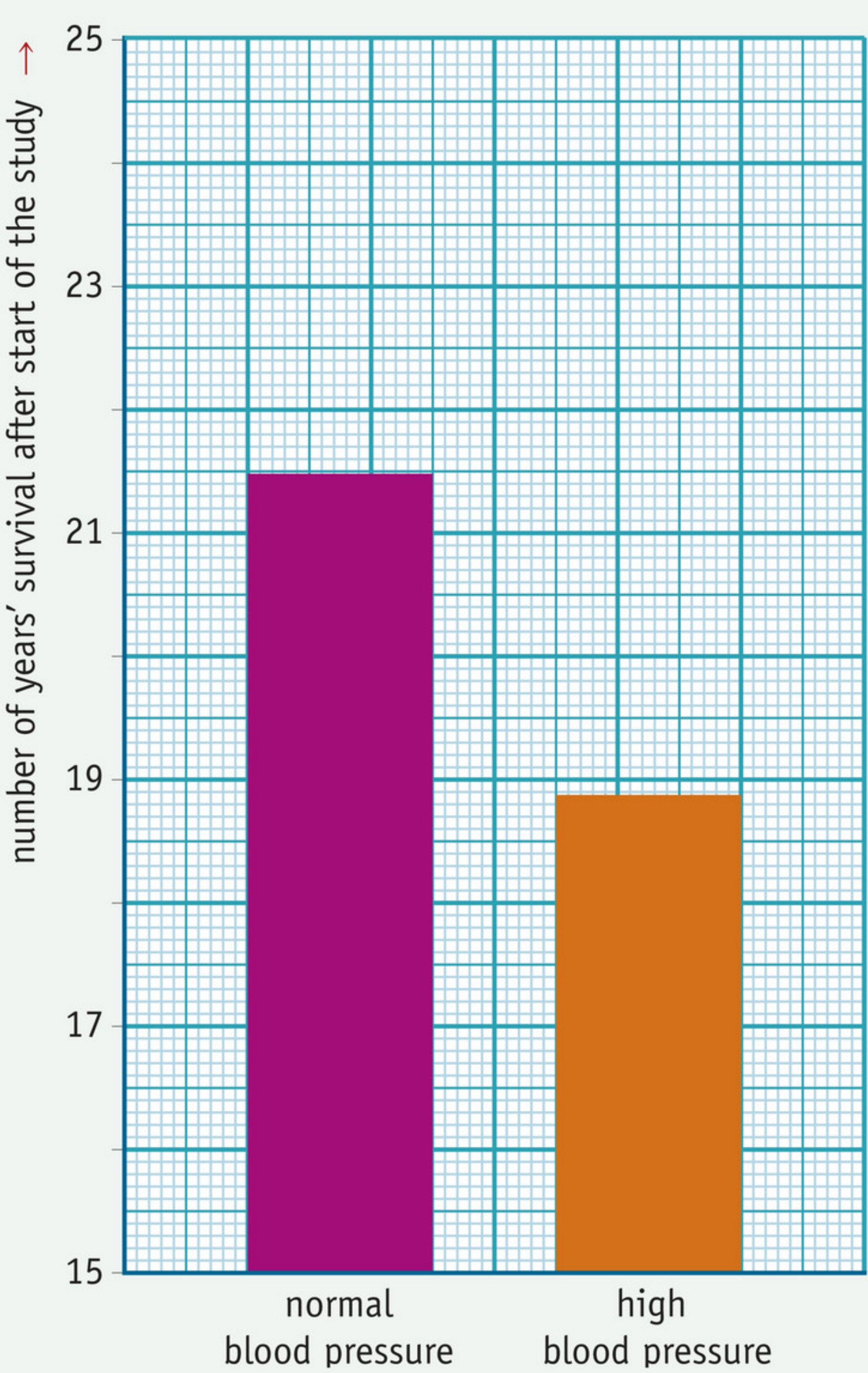
▼ Fig. 30

Research into blood pressure

A lot of research is carried out into blood pressure. This research is simple and quick to carry out. A doctor measures the blood pressure, usually at an artery in the arm. Research shows that high blood pressure affects life expectancy. American researchers measured the blood pressures of a group of 2239 men aged 56 to 68 and followed their BP until they died. The graph shows how long men with and without high blood pressure lived on average after the start of the study.

	Systolic pressure	Diastolic pressure
Low blood pressure	< 90	< 60
Optimum blood pressure	approximately 120	approximately 80
Healthy blood pressure	< 140	< 90
High blood pressure	140 to 160	90 to 100
Very high blood pressure	> 160	> 100

1 low, optimum, healthy or high blood pressure

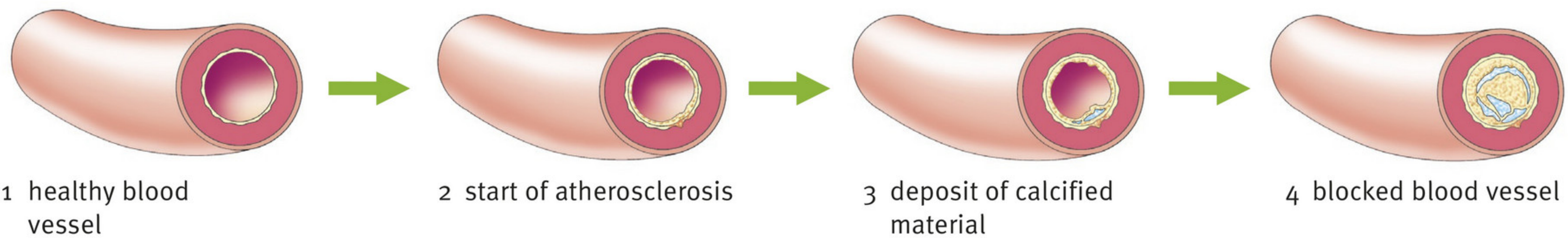


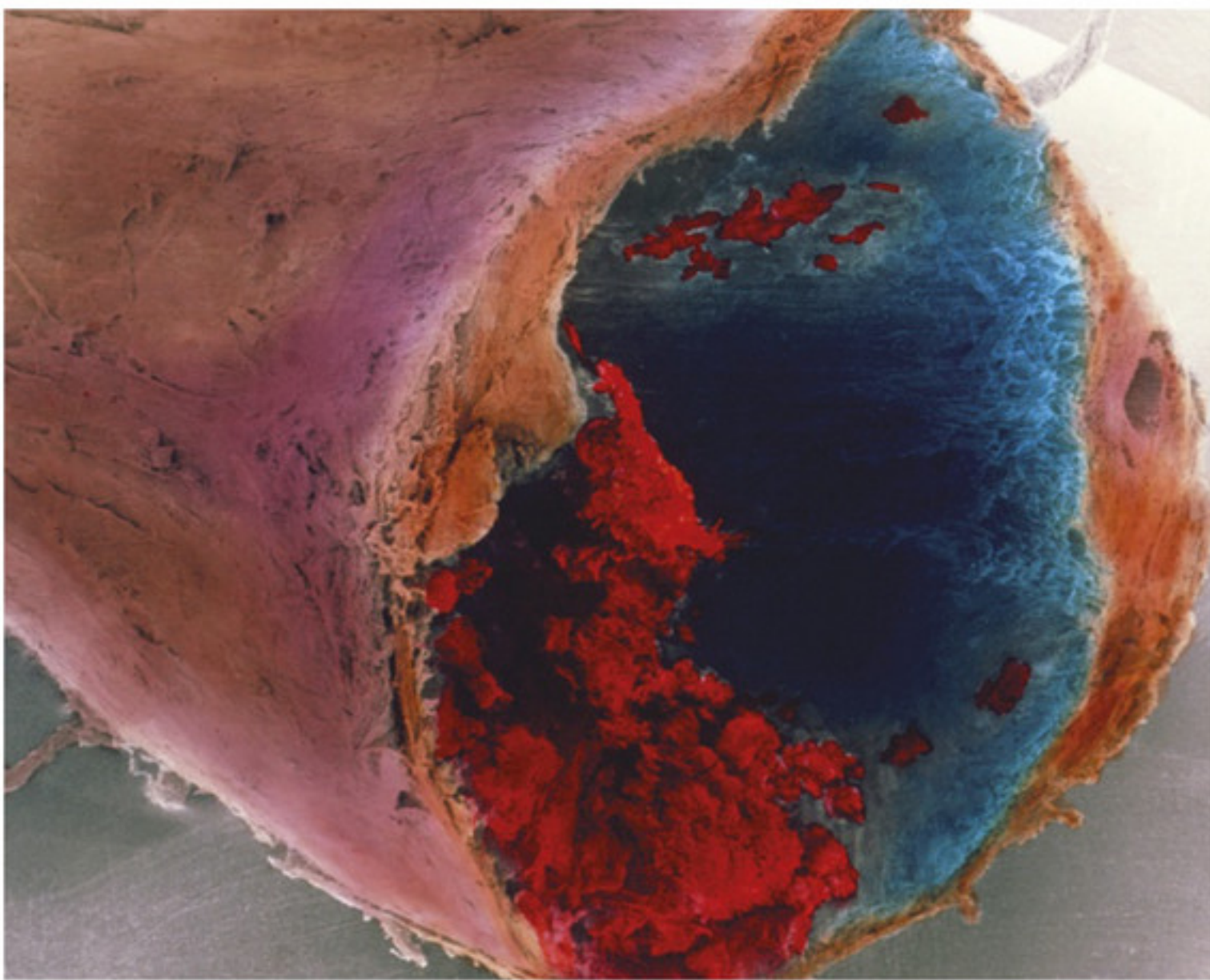
2 effect of high blood pressure on life expectancy

ATHEROSCLEROSIS

Blood can flow freely through healthy blood vessels. Fatty substances such as **cholesterol** from the blood can stick to a blood vessel wall, especially when the blood vessel wall has been damaged by high blood pressure, for example. This creates a fatty, pulpy layer on which chalky deposits can settle. We call this **atherosclerosis** (see figure 31). These chalky deposits (calcification) make blood vessels more rigid, less elastic, increasingly narrow or even blocked. As a result, little or no blood is supplied to the organs or tissues. The reduced supply of oxygen and nutrients makes the organs and tissues work less well, or may even stop them functioning at all.

▼ Fig. 31 Atherosclerosis.



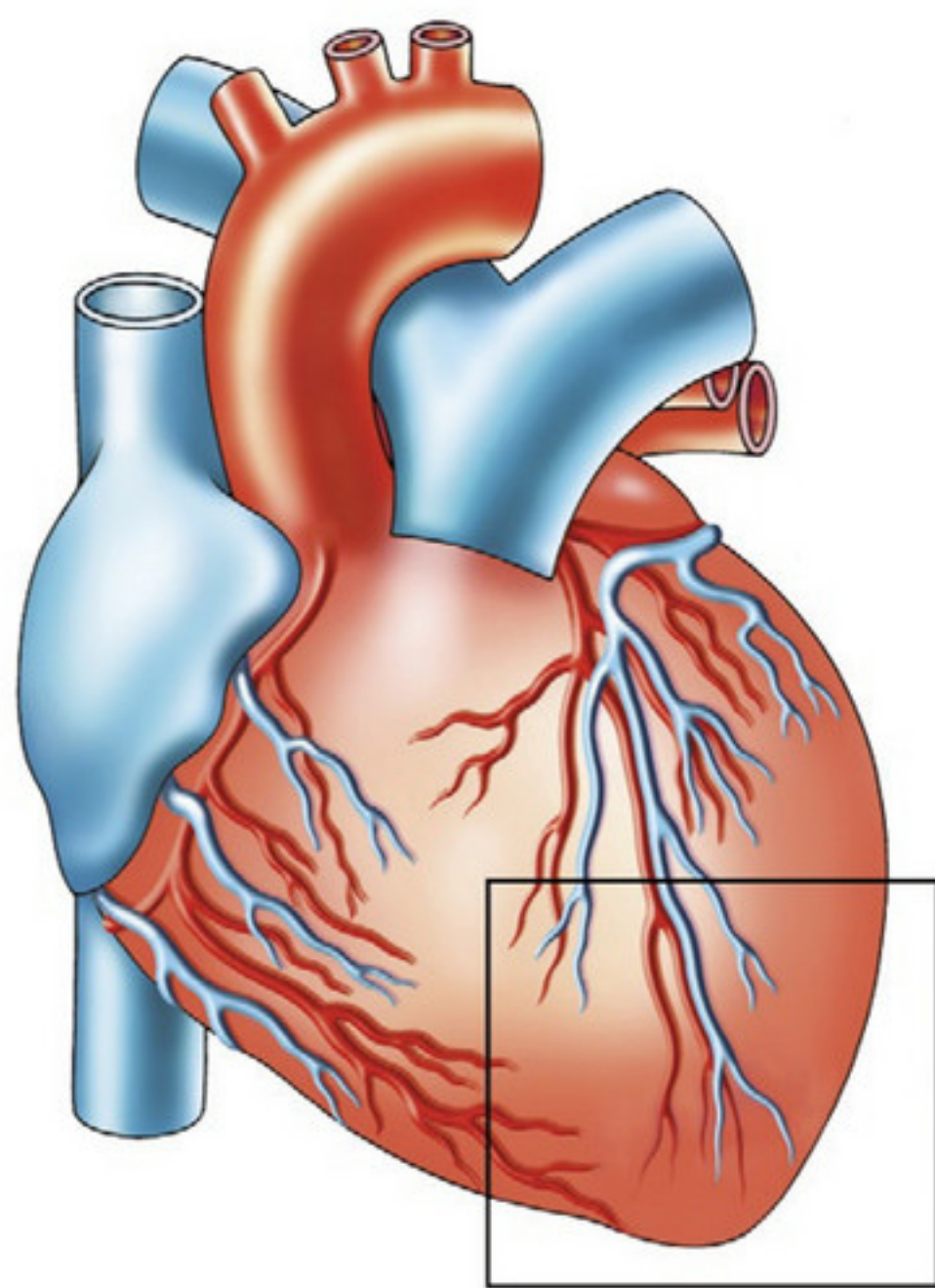
▼ **Fig. 32** Narrowing of a blood vessel.

The narrower and less elastic blood vessels mean that the blood pressure increases. The heart needs to pump harder in order to force blood through the narrowed blood vessels (see figure 32). The heart can become overloaded as a result. Atherosclerosis in a coronary artery can lead to a heart attack.

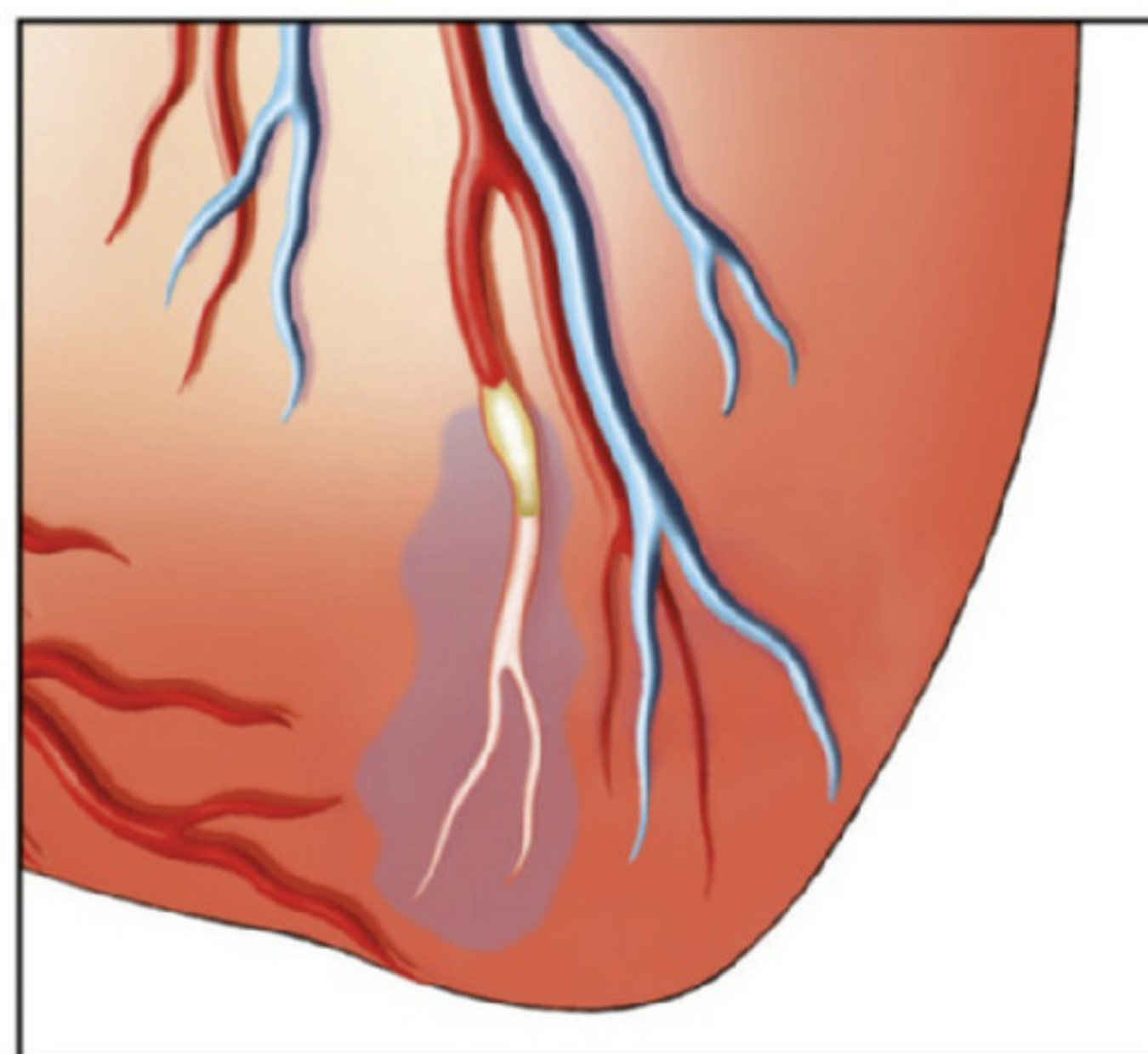
HEART ATTACK AND STROKE

If part of the heart muscle is no longer supplied with oxygen and nutrients, it can die off (see figure 33). We call that a **heart attack**.

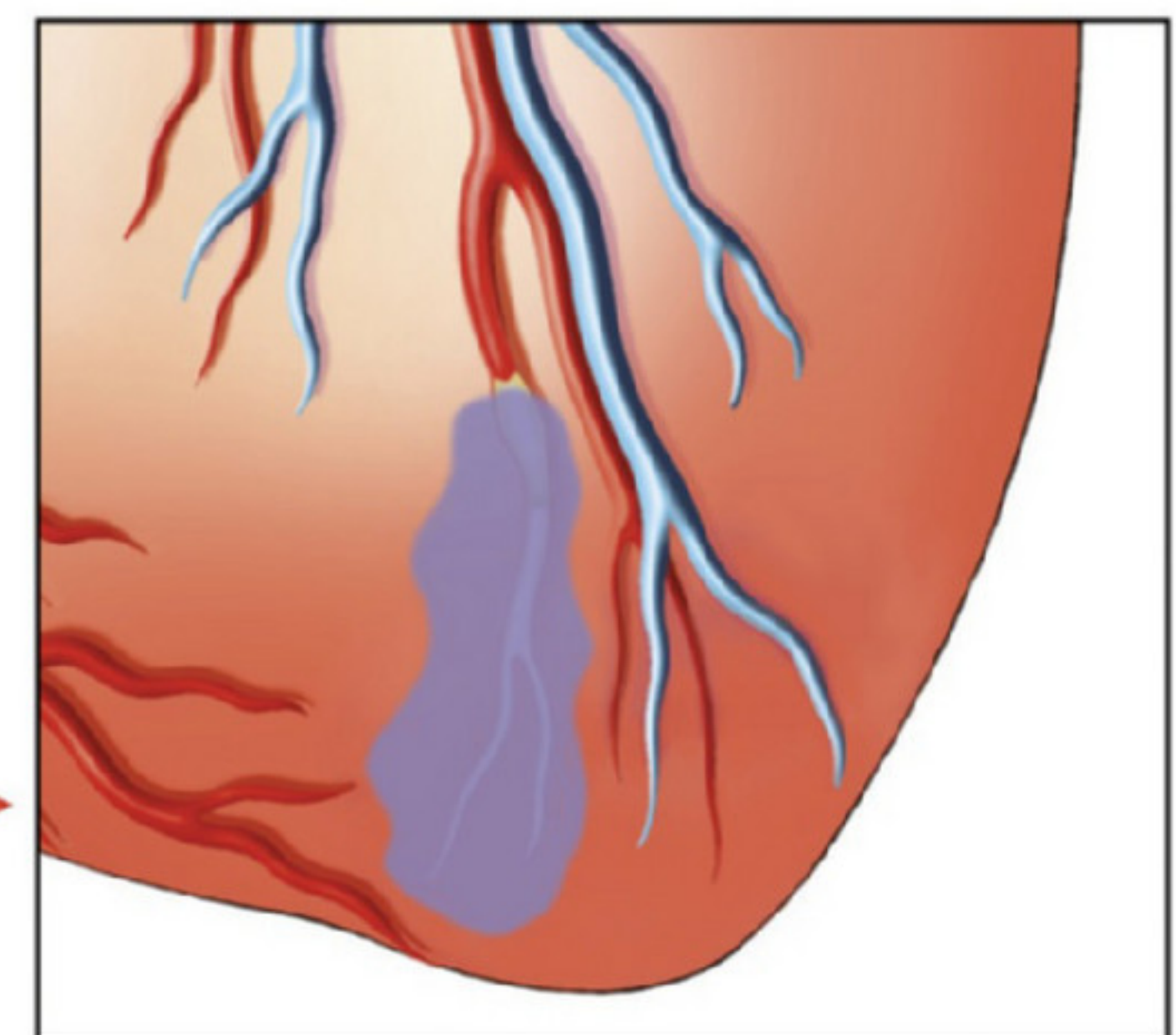
A heart attack is usually fatal if the part that has died off is large. However, most cardiac patients do not immediately get a severe heart attack. They usually get a 'warning' first. When a small branch of the coronary artery gets clogged, there is usually another branch that can take over.

▼ **Fig. 33** Cardiac infarction.

1 a healthy heart

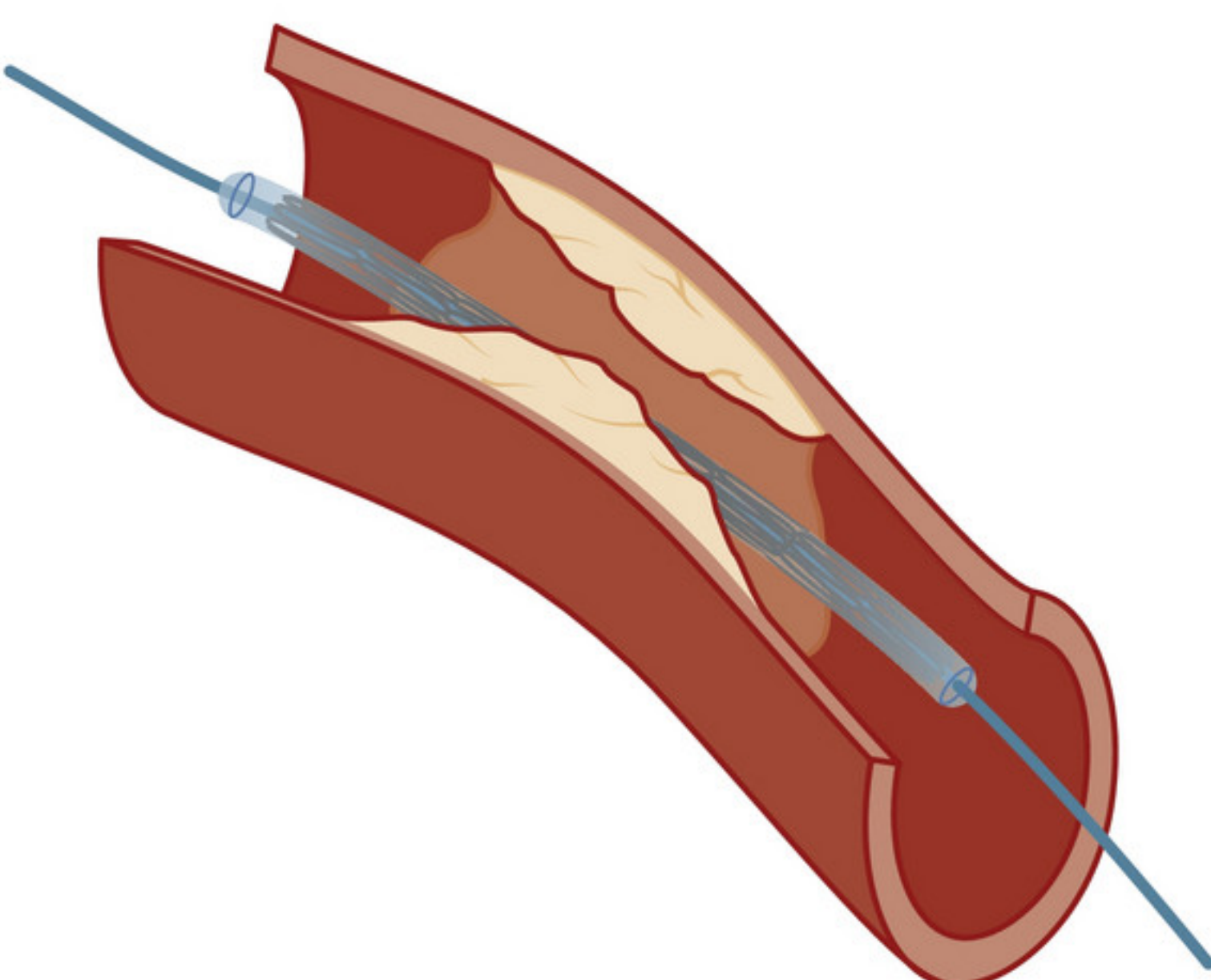


2 a branch of a coronary artery becomes blocked, so that part of the heart does not get enough oxygen and nutrients

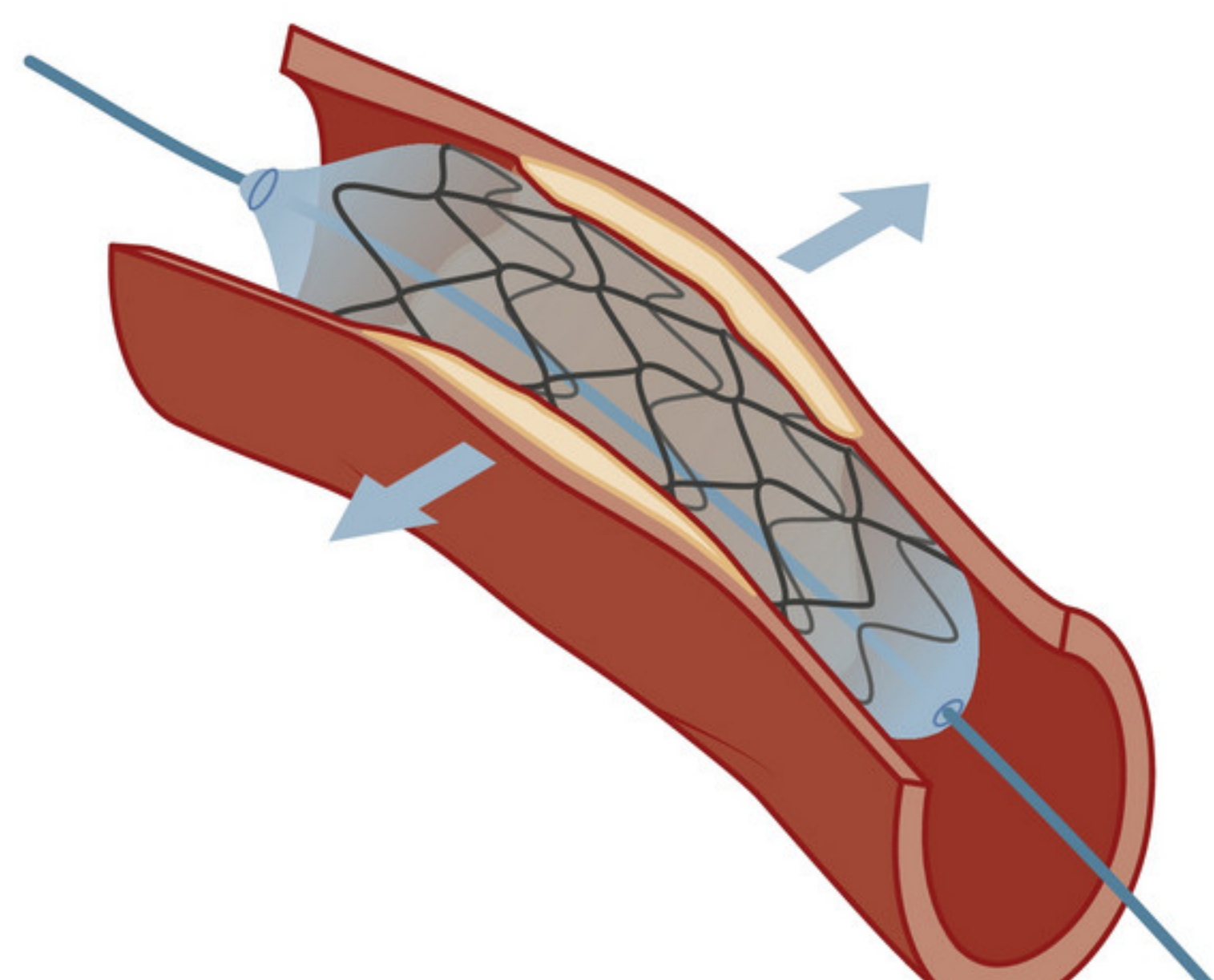


3 part of the heart muscle tissue dies

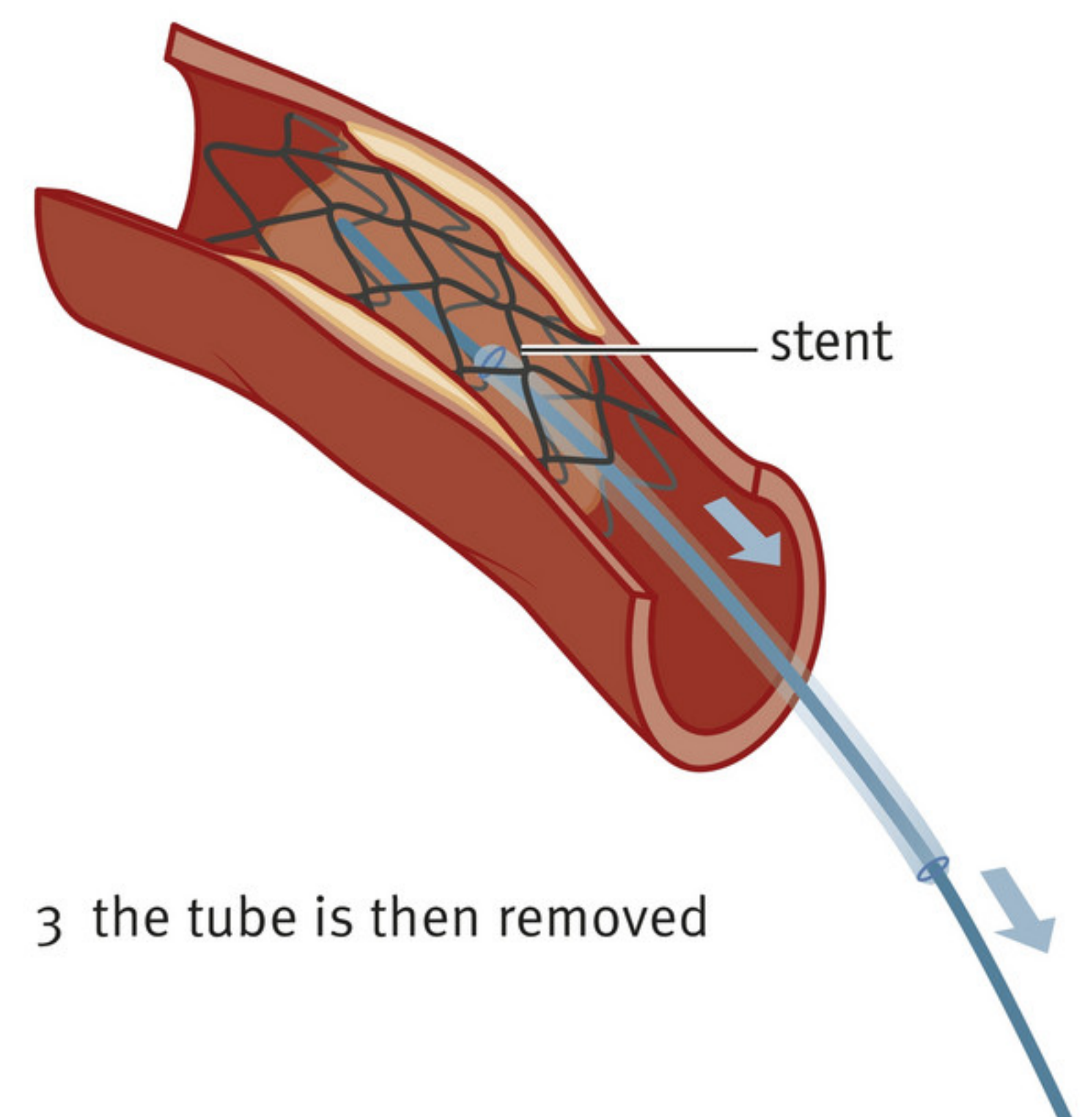
If a coronary artery is severely narrowed, it can be treated by a technique called **angioplasty**. During the treatment, the coronary artery is widened with a kind of balloon inserted via a small incision in the groin (see figure 34). A stent may also be placed. This is a type of mesh tube made of metal wire that stretches and opens up the narrowed coronary artery, allowing blood to flow freely again.

▼ **Fig. 34** Angioplasty with a stent being put in place.

1 a tube with a balloon and a stent at the end is inserted into the coronary artery



2 when the balloon is pumped up, the calcified deposits break up



3 the tube is then removed

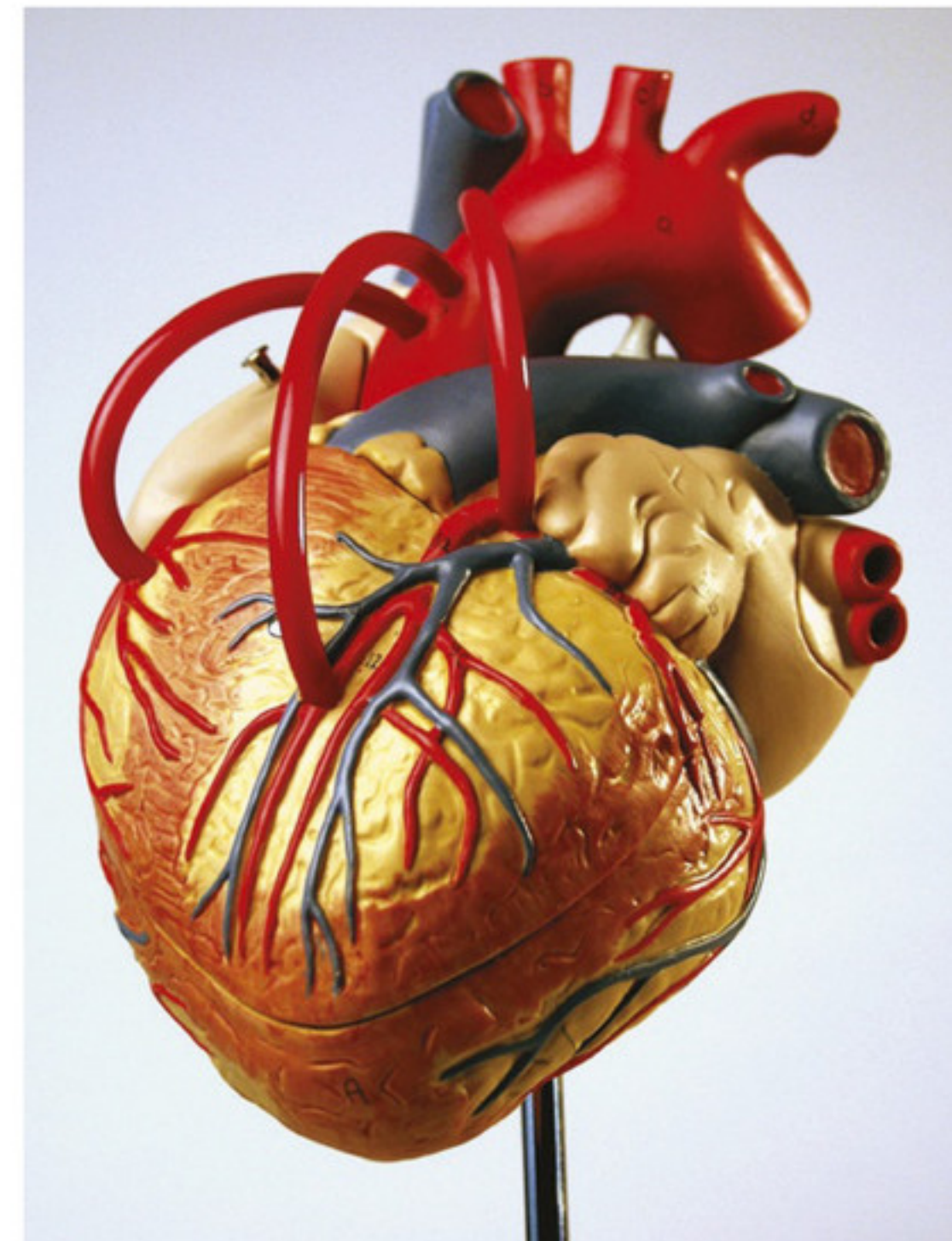
Bypass surgery means making a detour around the narrowed part of the blood vessel (see figure 35). This usually is done with a piece of a blood vessel taken from the leg. Figure 36 shows a model of a heart with bypasses. You can hear what a nurse and a cardiologist have to say in figure 37.

A **stroke** happens when a blood vessel in your brain has been blocked by atherosclerosis or a blood clot. The brain tissue beyond the blockage is no longer being supplied with oxygen and nutrients.

▼ **Fig. 35** Bypass surgery.



▼ **Fig. 36** Model of the heart with bypasses.



▼ **Fig. 37**

A&E nurse and cardiologist

At the accident and emergency department (A&E), there is a team of A&E doctors, A&E nurses and a secretarial office available 24 hours a day for emergencies, both for adults and for children.

Hallo. I'm Khadija and I work as a nurse on the accident and emergency ward. It's a job that you need to be very good with people for – you need a lot of empathy with what are often worrying situations for them. You must be able to keep your head cool and do the right things quickly at the right moment. Specialists then often take the work over from me. For example, a cardiologist (a heart specialist) may come in if somebody needs angioplasty or if a stent has to be put in place.

Hallo. I'm Maria. I'm a cardiologist, which means I treat heart patients, for instance with angioplasty or stents. If a bypass operation is needed, I discuss it with the cardiac surgeon. A common saying in our field is that 'time is muscle': almost every second that you take making your mind up can mean more heart muscle dying. So you are regularly working under major time constraints.



PREVENTING CARDIOVASCULAR DISEASES

Hereditary factors play a key role in the risk of getting cardiovascular diseases. Some people have increased cholesterol levels due to hereditary factors, for example. There is nothing you can do about these causes. People with these conditions can take medicines designed to lower cholesterol levels. You can influence other causes of cardiovascular diseases, for example by not smoking and by maintaining a healthy weight (see figure 38). The most important way of preventing cardiovascular disease is to have a healthy lifestyle. Figure 39 gives advice about a healthy lifestyle.

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► **Fig. 38** An unhealthy lifestyle.



▼ **Fig. 39**

RECOMMENDATIONS FOR A HEALTHY LIFESTYLE

- 1 Not smoking is very important for the heart and blood vessels.
- 2 Adults: do not drink more than two glasses of alcohol per day.
Teenagers: do not drink alcohol until you are 18 (or better still, not until you are 24).
- 3 Eat a healthy and varied diet: enough vitamins, minerals and fibre, and not much saturated fat. Do not use much salt.
- 4 Make sure you get regular exercise (at least half an hour per day).
- 5 Make sure you have a healthy bodyweight.

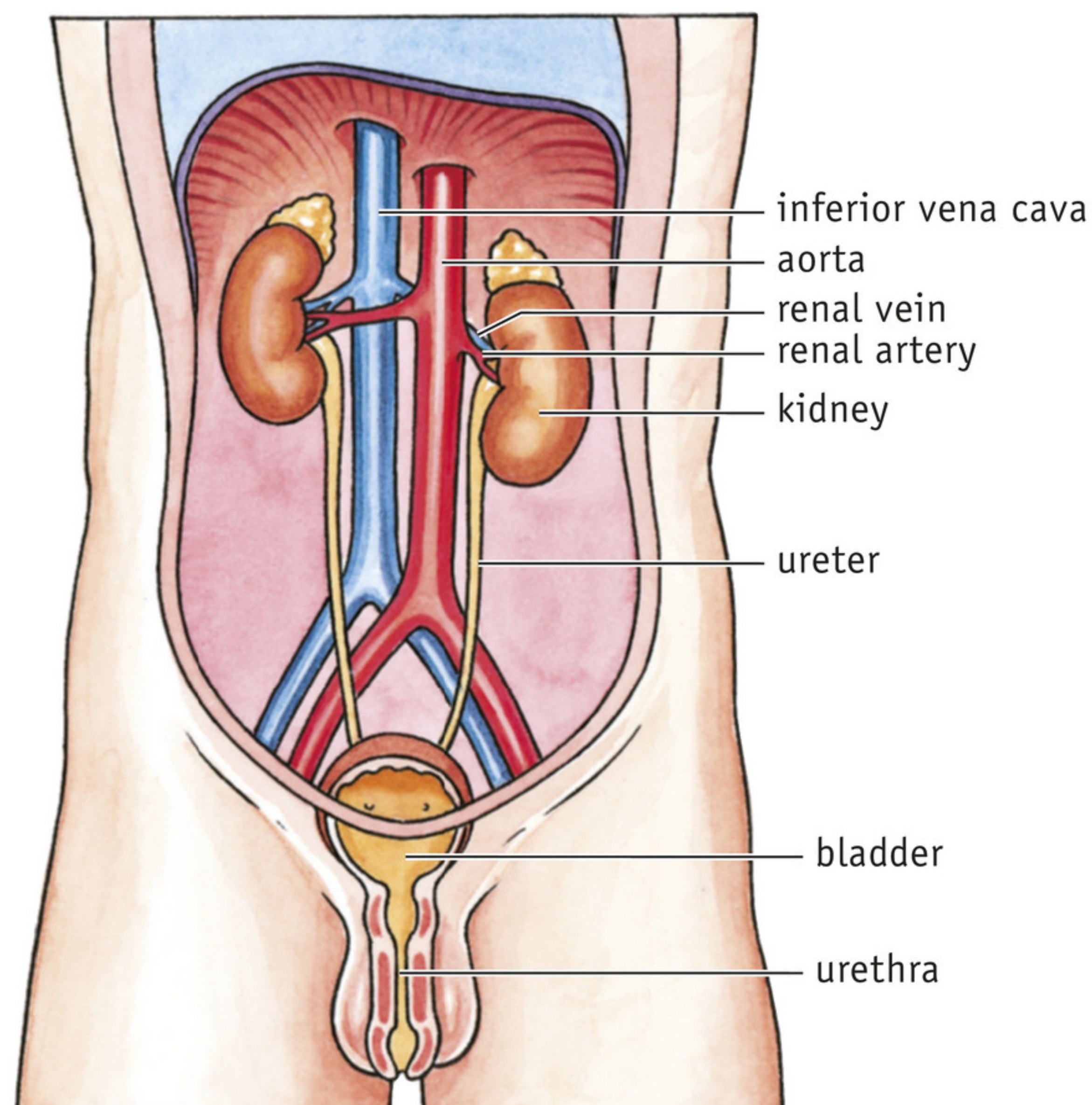
6 Excretion

Excretion takes place in special organs. You learned in unit 1 (Breathing and respiration) that the lungs eliminate carbon dioxide. Most other waste products are excreted via the kidneys.

KIDNEYS AND URINARY TRACT

The **kidneys** are located in the abdominal cavity, to the left and right of the backbone, just below the diaphragm (see figure 40). Oxygenated blood flows through the **renal arteries** to the kidneys. This blood contains waste products from many organs. The kidneys extract the waste products from the blood. This purified blood flows out of the kidneys through the **renal veins**.

► **Fig. 40** The kidneys and the urinary tract (schematic).

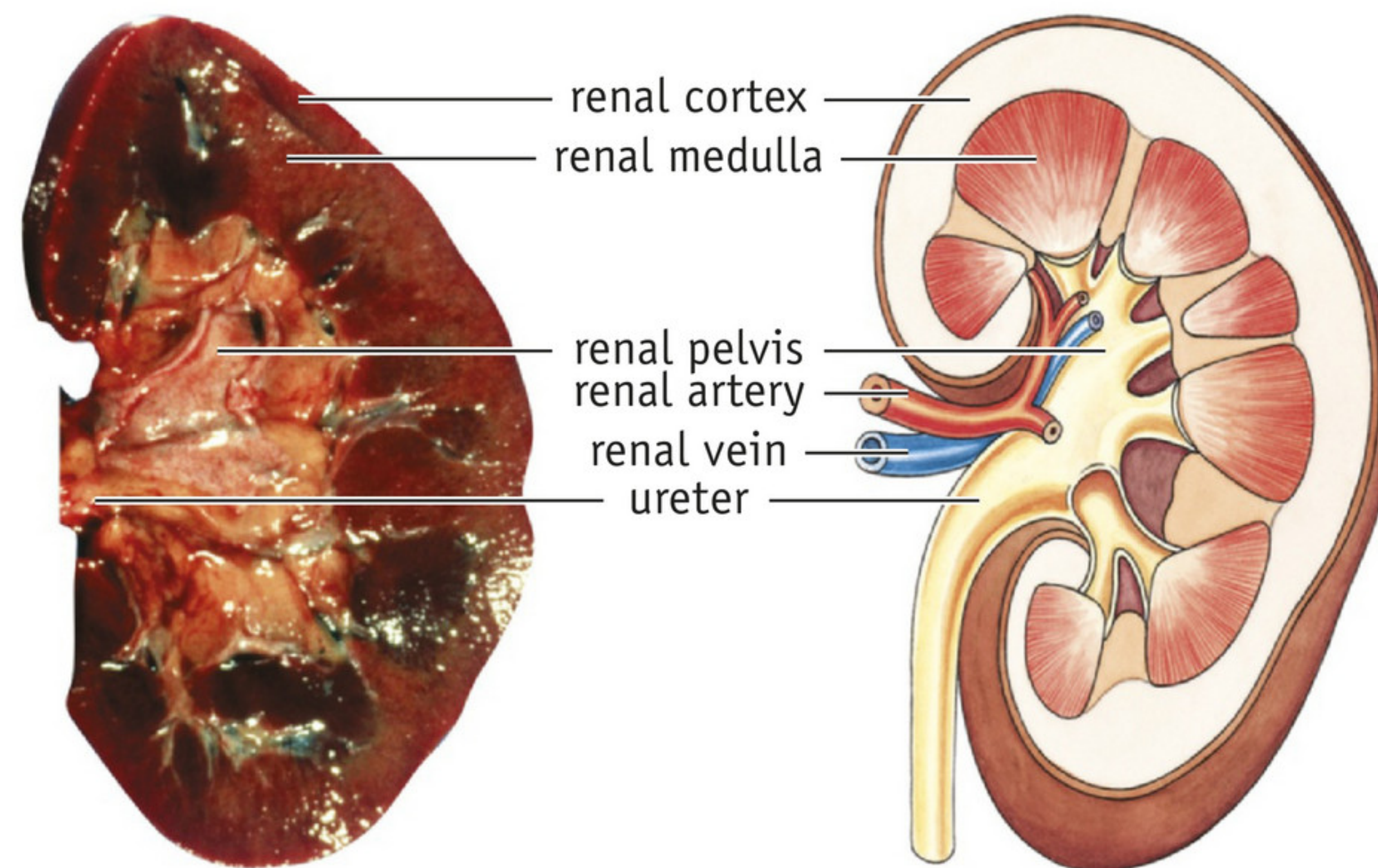


A kidney is composed of the **renal cortex**, **renal medulla** and **renal pelvis** (see figures 41 and 42). The renal cortex and renal medulla not only remove waste products from the blood, but also remove excess water, salts and all kinds of harmful substances. We call all of these substances combined **urine**.

▼ **Fig. 41** Human kidney.



▼ **Fig. 42** Longitudinal section of a kidney.



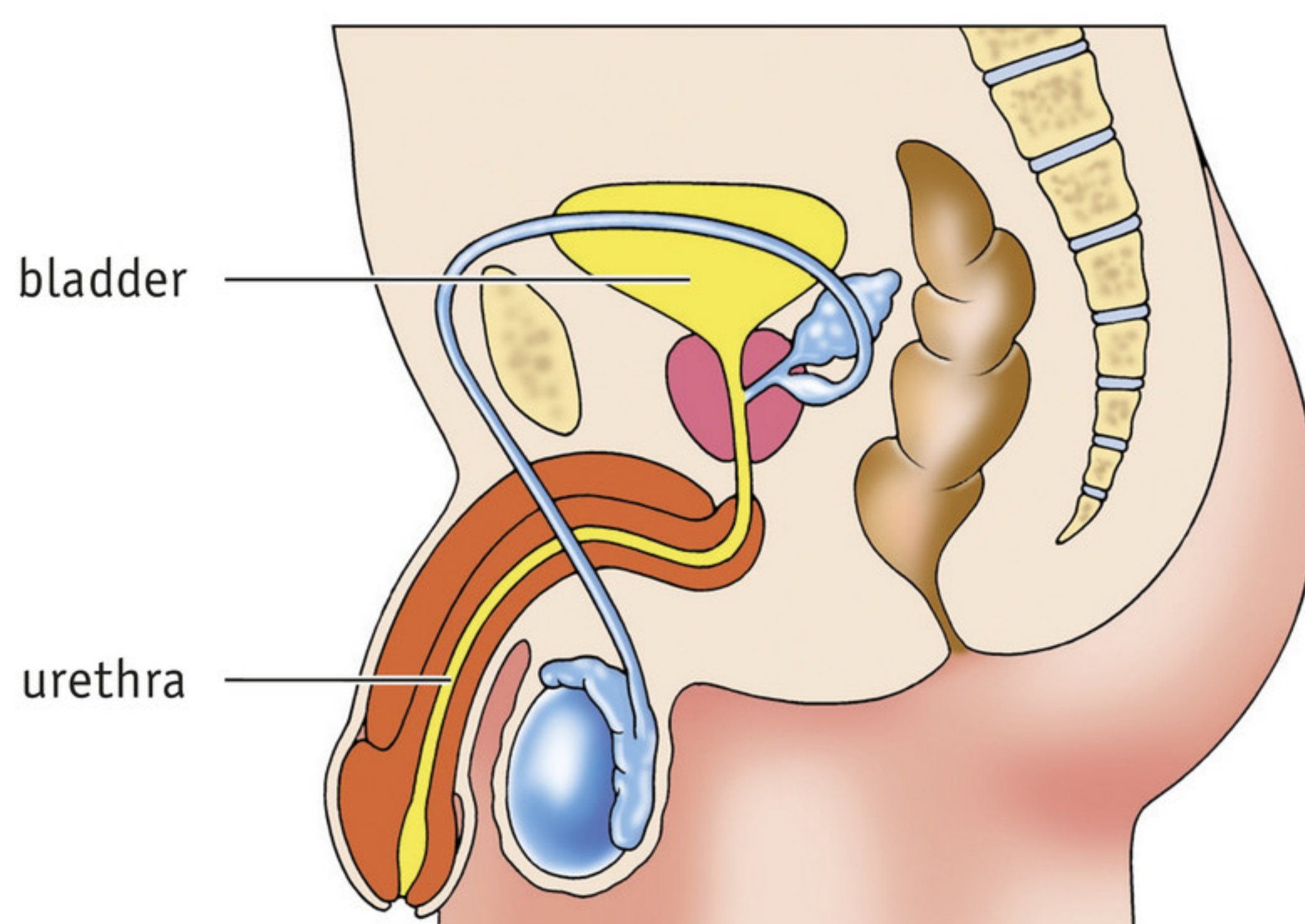
1 photo

2 schematic drawing

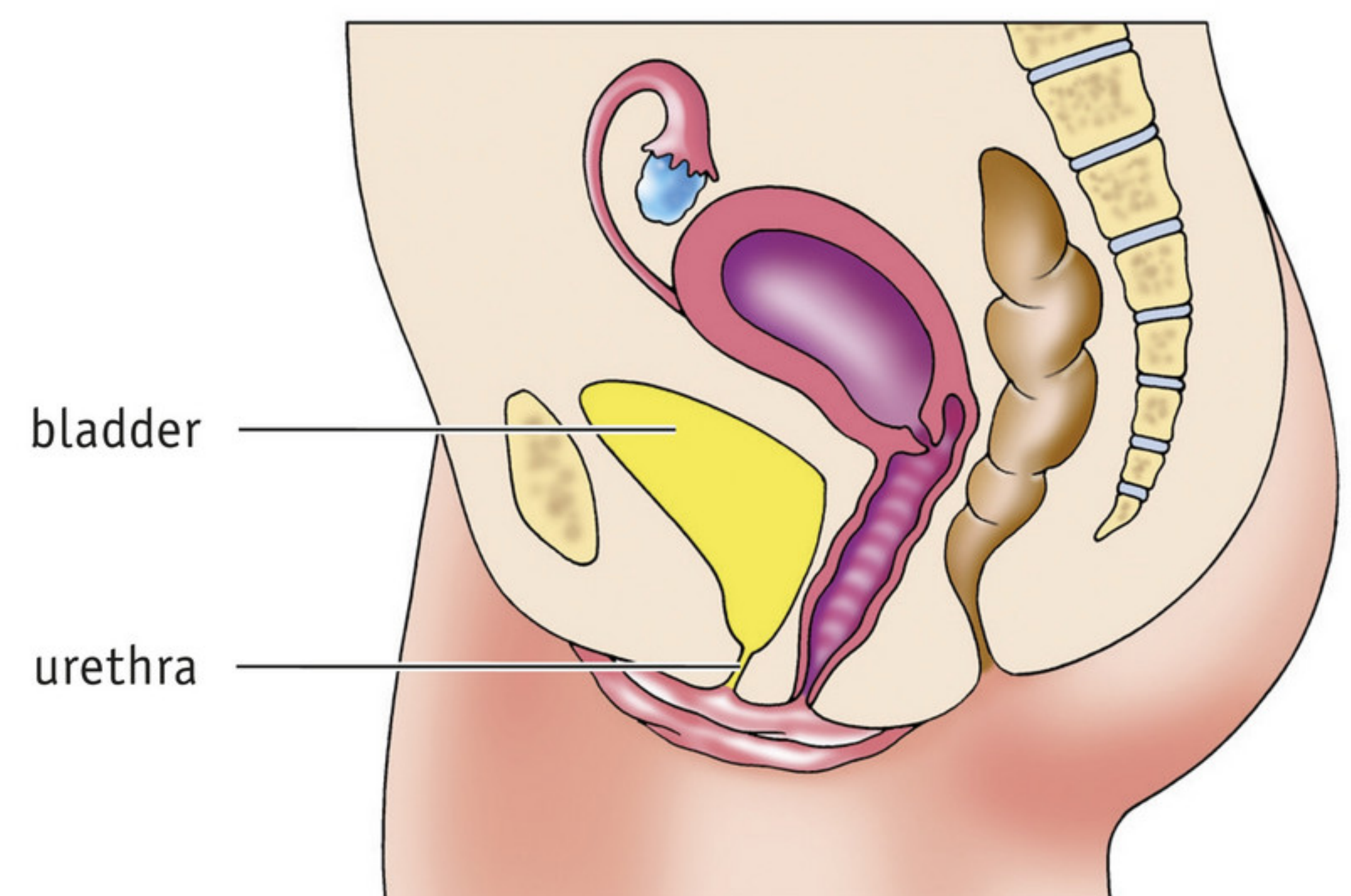
Urine is collected in the renal pelvis, from where it is carried to the **bladder** through the **ureters** (see figure 43). Urine is stored temporarily in the bladder, so that you do not have to urinate all the time. When you do, urine gets transported from the bladder through the **urethra**.

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▼ **Fig. 43** Location of the bladder and urethra (schematic).



1 in men



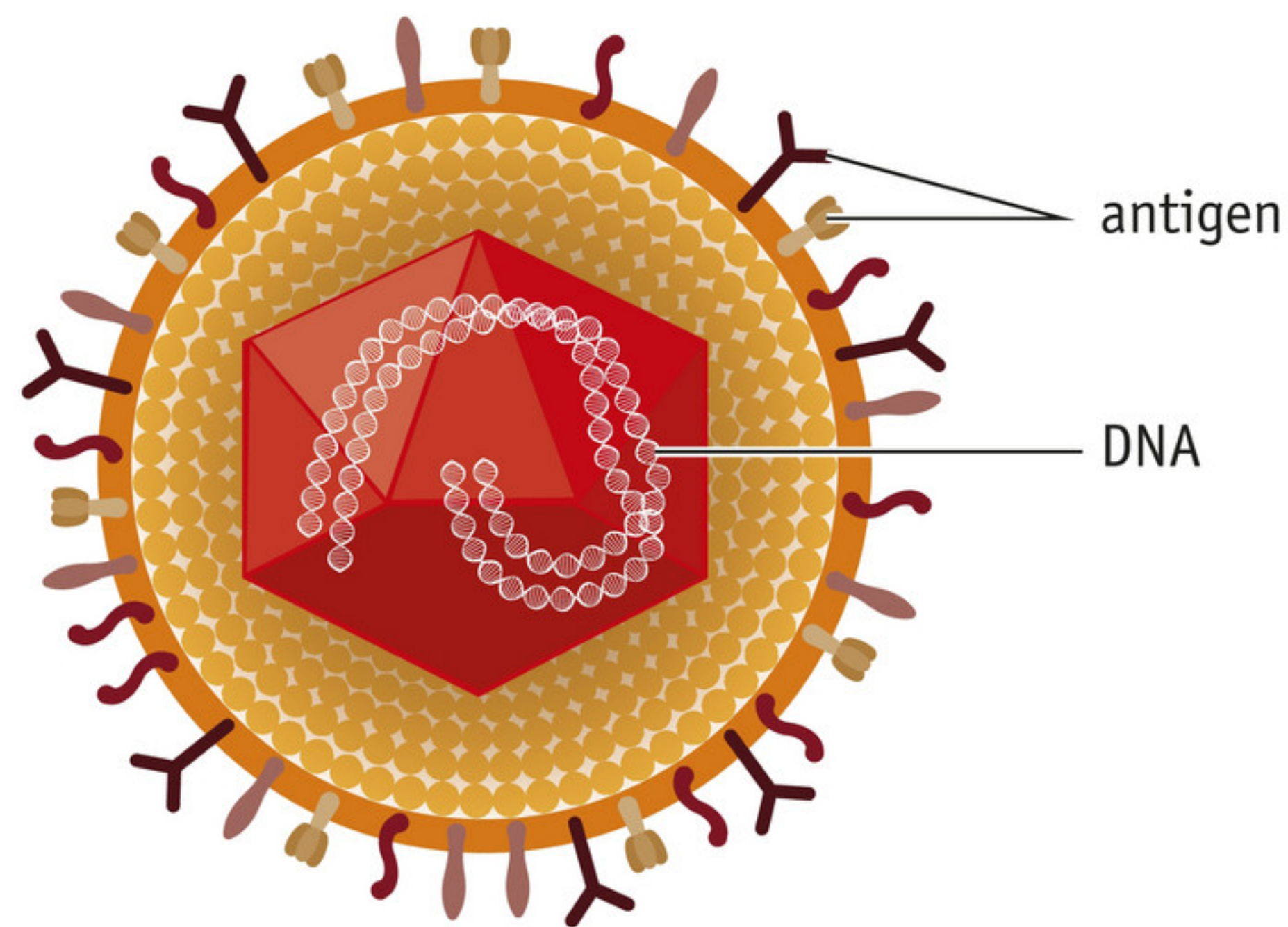
2 in women

7 The immune system

Substances that do not belong in your body are called **foreign bodies** or **antigens**. When these substances enter your body, the **immune system** reacts to them. This can happen during infections and blood transfusions, for example.

An **infection** is when pathogens carrying antigens enter your body. Pathogens are usually bacteria or viruses (see figure 44). **Viruses** are not generally reckoned to be living creatures.

► **Fig. 44** Virus.



1 virus with antigens

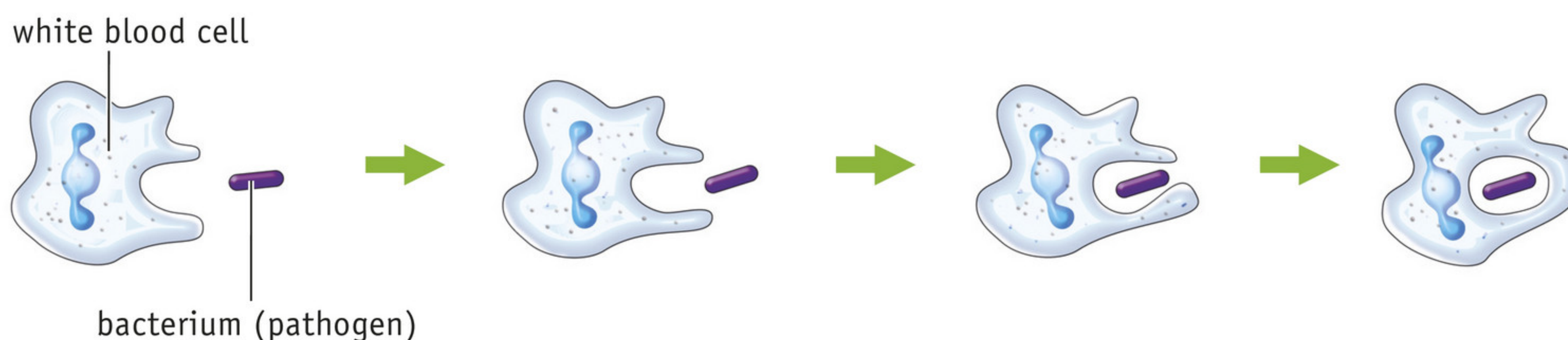


2 cold sores are caused by a virus

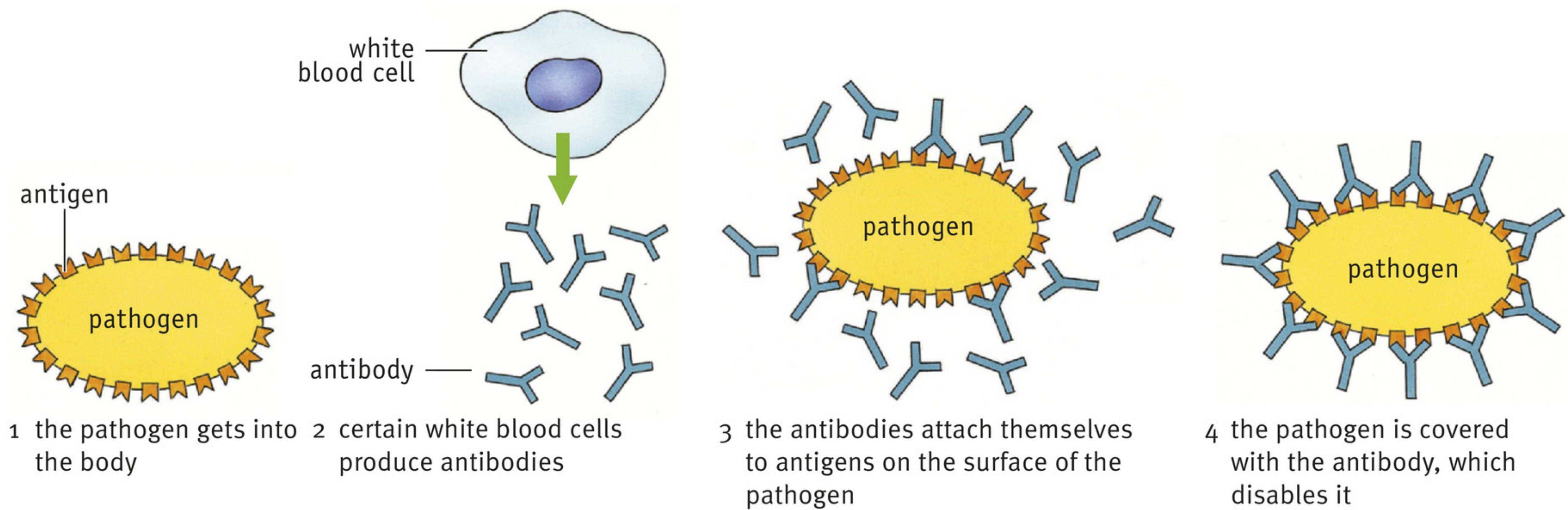
ANTIBODIES

You learned in basics 1 that certain white blood cells destroy pathogens by engulfing and digesting them (see figure 45). Another type of white blood cells reacts to pathogens by making **antibodies**. When pathogens have entered your body, the immune system recognises them as a foreign body (antigen). White blood cells will then start making antibodies against them.

▼ **Fig. 45** White blood cell killing a bacterium (diagram).



▼ **Fig. 46** Producing an antibody against a pathogen (diagram).



The antibodies attach themselves to the antigens of the pathogen. This disables the pathogen (see figure 46).

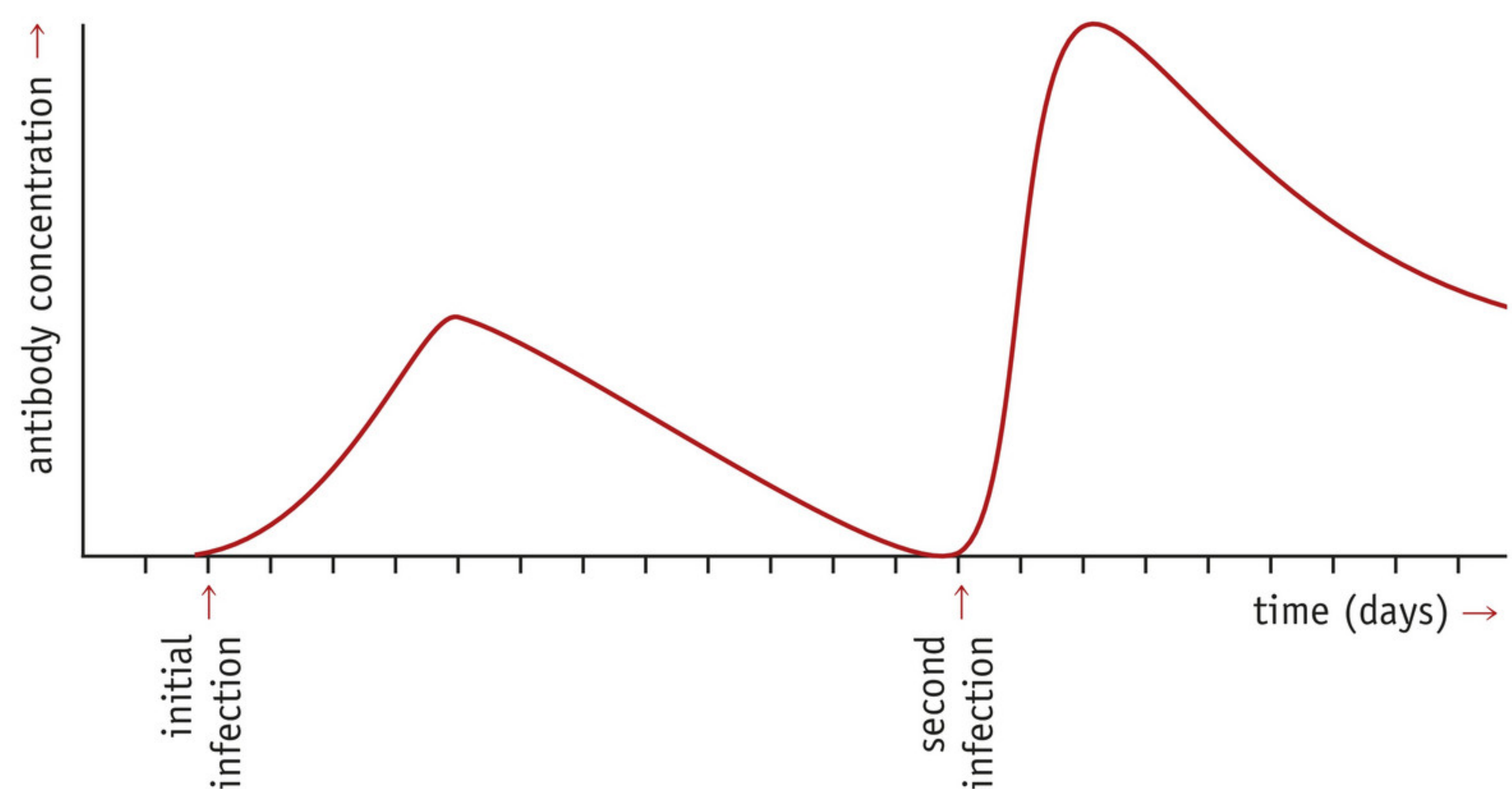
Various different pathogens contain different foreign bodies. One type of antibody can only attach itself to one type of foreign body, so your body has to make many different antibodies.

NATURAL IMMUNITY

When you get an infection, it takes a while for the white blood cells to make enough antibodies to fight the pathogen (see figure 47). That is why you often get sick first. You will get better when enough antibodies have been made.

Antibodies made by your body will stay in your bloodstream for quite a while afterwards. The white blood cells also 'remember' how these antibodies were made, so when you get infected by the same pathogen later on your body can make the antibodies almost immediately (see figure 47). Your white blood cells are able to make large amounts of antibodies within a short period of time, and you will not get sick. You have now become **immune** to this disease.

► **Fig. 47** The amounts of antibody in the blood after twice being infected by the same pathogen.



▼ Fig. 48 Child with chickenpox.



▼ Fig. 49 A girl getting vaccinated.



► Fig. 50 Vaccination schedule.

Many children get chickenpox as toddlers (see figure 48). They get sick and make antibodies to fight the pathogen. This gives them lasting **immunity** to chickenpox. Because these children have combated the disease themselves, we call this **natural immunity**.

ARTIFICIAL IMMUNITY

Immunity can be created artificially. This happens when you are vaccinated against diseases like measles. This is called **vaccination** (see figure 49). Vaccination means getting an injection of a **vaccine**. A vaccine contains a **dead pathogen** or a **weakened pathogen**. Specific white blood cells make antibodies to fight the pathogen. The pathogen is dead or weakened, so the worst that happens is that you will feel a little bit sick. If you later get infected by the live pathogen, your white blood cells will be able to make antibodies almost immediately. You have become immune and will not get sick. This is known as **artificial immunity**.

Almost all children in the Netherlands are vaccinated against several infectious diseases (see figure 50). Since the introduction of vaccinations in the Netherlands, many of these diseases have either almost disappeared or have been eliminated entirely. You can also get vaccinations when you are going to travel to a country where the chances of getting infectious diseases are high.

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Phase 1					Phase 2	Phase 3	Phase 4
6-9 weeks	3 months	4 months	11 months	14 months	4 years	9 years	12 years
Jab 1 DTaP/IPV Hib HepB	DTaP/IPV Hib HepB	DTaP/IPV Hib HepB	DTaP/IPV Hib HepB	MMR	DTaP/IPV	DT/IPV	HPV (2 x 1 jab)
Jab 2 Pneu		Pneu	Pneu	MenC		MMR	

Legend:

- D

= diphtheria
- aP

= acellular pertussis (whooping cough)
- T

= tetanus
- IPV

= inactivated polio virus
- Hib

= haemophilus influenzae type b
- HepB

= hepatitis B
- Pneu

= pneumococci
- M

= mumps
- M

= measles
- R

= rubella
- MenC

= meningococcus C
- HPV

= human papilloma virus
(causes cervical cancer)

8 Alcohol and cannabis

Alcohol and cannabis end up via the blood in almost all parts of your body after being consumed. This affects all kinds of organs such as your liver, your senses and your nervous system. After getting broken down by the liver, the degradation products of alcohol and drugs are excreted in the urine via the kidneys. There are tests to see if someone has consumed alcohol or cannabis (see figure 51).

▼ Fig. 51 Alcohol and cannabis tests.



1 breath test for alcohol consumption



2 saliva test for cannabis use



3 blood test (the most accurate test for both alcohol and cannabis consumption)

ALCOHOL

Pure alcohol (ethanol) is a clear, colourless and flavourless liquid. Alcoholic drinks consist of alcohol, water and flavourings. Alcoholic drinks are generally grouped into three categories: beer, wine and spirits (see figure 52).

▼ Fig. 52



	Beer	Wine	Spirits
Made from	grain	grapes (or other fruit)	– grain (e.g. gin) – potatoes (e.g. vodka) – fruit (e.g. cognac)
Volume of 1 glass	250 mL	100 mL	35 mL
Alcohol percentage	5%	12%	35%

Alcohol is mainly absorbed into the blood through the small intestine and is broken down in the liver. The alcohol level in the bloodstream is also known as the **blood alcohol content (BAC)**. The blood alcohol content depends on the bodyweight and how long the alcohol has been in the body. An adult man absorbs a glass of beer into his bloodstream in about half an hour and breaks it down in another hour.

Large quantities of alcohol are harmful and long-term consumption of large quantities of alcohol is addictive. Figure 53 shows the **short-term effects of alcohol** when various quantities of alcohol have been drunk. It also shows permillages (‰). One permille of alcohol means one milligram of alcohol per millilitre of blood. A permillage of 0.5 means that 1 litre of blood contains 0.5 grams of pure alcohol.

Consuming too much alcohol makes it very likely you will get a **hangover**. You will then have a headache and be really thirsty. Drinking even more sometimes makes you throw up. Ultimately, you can even lose consciousness or go into a coma. You are then suffering from severe alcohol poisoning.

▼ Fig. 53

THE SHORT-TERM EFFECTS OF ALCOHOL

1 to 3 drinks: relaxing (0 to 0.5 permille alcohol in the blood)

Quicker pulse and breathing rate; blood vessels dilated; reduced senses of taste, smell and sight; reduced sense of pain.



3 to 7 drinks: tipsy (0.5 to 1.5 permille alcohol in the blood)

Overconfidence; reduced inhibitions; impaired memory; poor muscle coordination and reaction time; impaired judgement of situations.



7 to 15 drinks: drunk (1.5 to 3 permille alcohol in the blood)

Self-criticism disappears; heightened emotions; face gets red or swollen; pupils dilate; nausea.



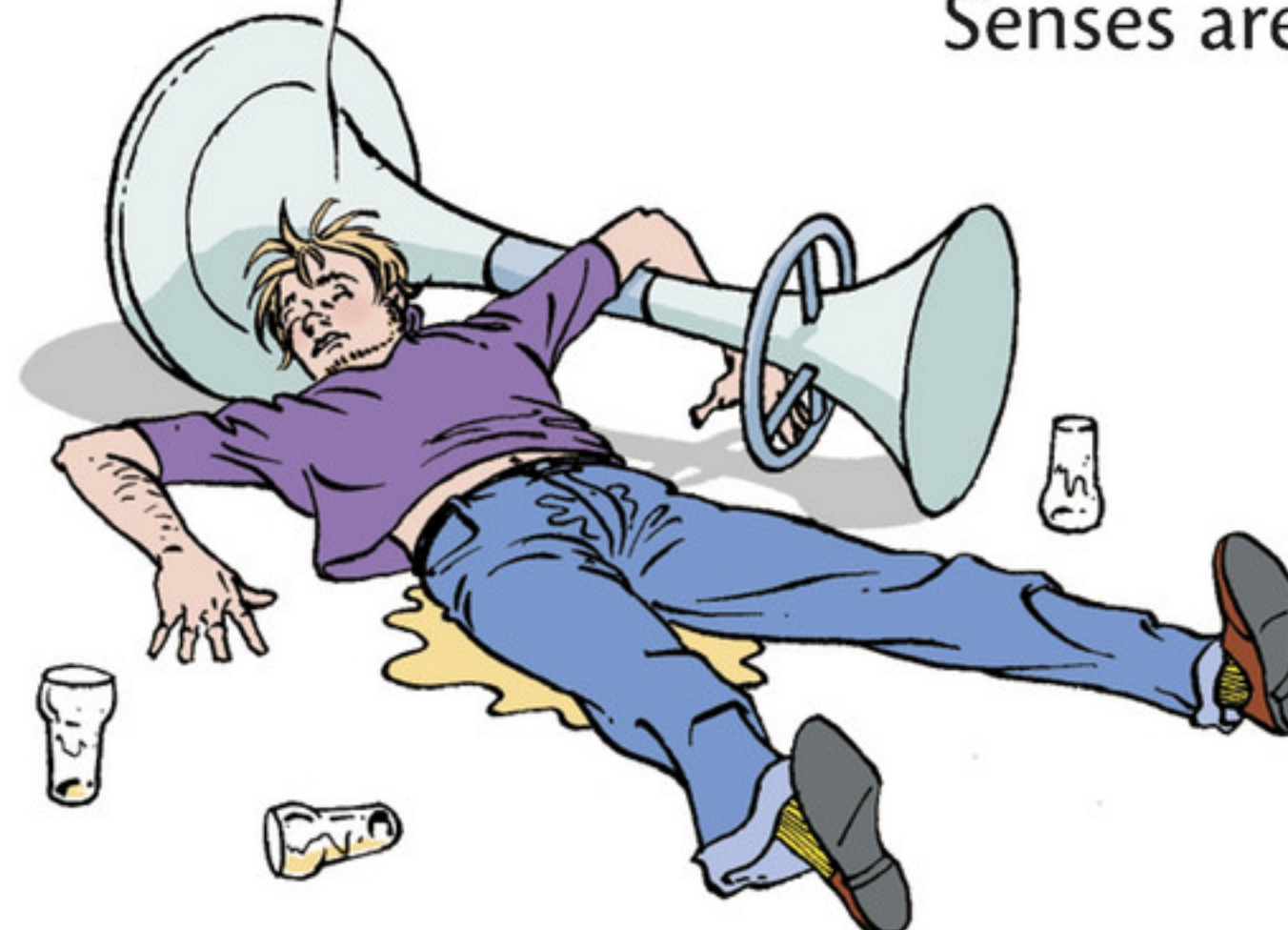
15 to 20 drinks: drunk (3 to 4 permille alcohol in the blood)

Senses are numbed.



20 to 25 drinks or more: unconscious (4 to 4 permille alcohol in the blood)

Slow breathing and pulse; risk of coma and death by respiratory or cardiac arrest.



There are also **long-term effects of alcohol**. You learned in part 1 that alcohol disrupts the development of the brain, for example. Alcohol also disrupts the hormone balance. Drinking too much alcohol can cause memory loss and damage to the liver, brain, stomach and heart. People who drink too much alcohol perform less well at school, in their studies and at work.

Binge drinking means drinking too much alcohol in a short period of time, making the blood alcohol level quickly rise above 0.8 permille. An adult man can reach this concentration if he has six drinks within two hours. Young people are more sensitive to the effects of alcohol than adults. Binge drinking is a major health hazard. The sudden high concentrations of alcohol can for instance severely damage many organs, especially the brain. Finnish researchers have shown that binge drinking also affects the likelihood of having a stroke (see figure 54). Drinking a few glasses of alcohol every now and then is not harmful for adults.

▼ Fig. 54

INVESTIGATION THE EFFECT OF BINGE DRINKING ON STROKE			
Question	Does binge drinking increase the risk of having a stroke?		
Experiment (observation)	A group of 15,965 people in Finland (roughly equal numbers of men and women) were grouped as those who were and were not regular binge drinkers. For ten years, both groups were monitored to see how many people had strokes.		
Result		Binge drinkers	Non-binge drinkers
	Number of experimental subjects	3558	12,407
	Number of strokes	122	57
	Number of men	2505	5510

Source: Increased stroke risk is related to a binge drinking habit (2008). L. Sundell et al., *ahajournals.org*.

▼ Fig. 55 Young cannabis plants (*Cannabis sativa*).



CANNABIS

Cannabis products such as hashish and marijuana come from the hemp plant, *Cannabis sativa* (see figure 55). The **active ingredient** in cannabis is **THC** (delta-9-tetrahydrocannabinol). THC is mostly found in the female flower buds of the hemp plant. Cannabis is smoked (a joint or in a pipe), eaten (space cake), drunk (marijuana tea) or inhaled after evaporation. Consumption of cannabis by road users is punishable by law.

EFFECTS OF CANNABIS

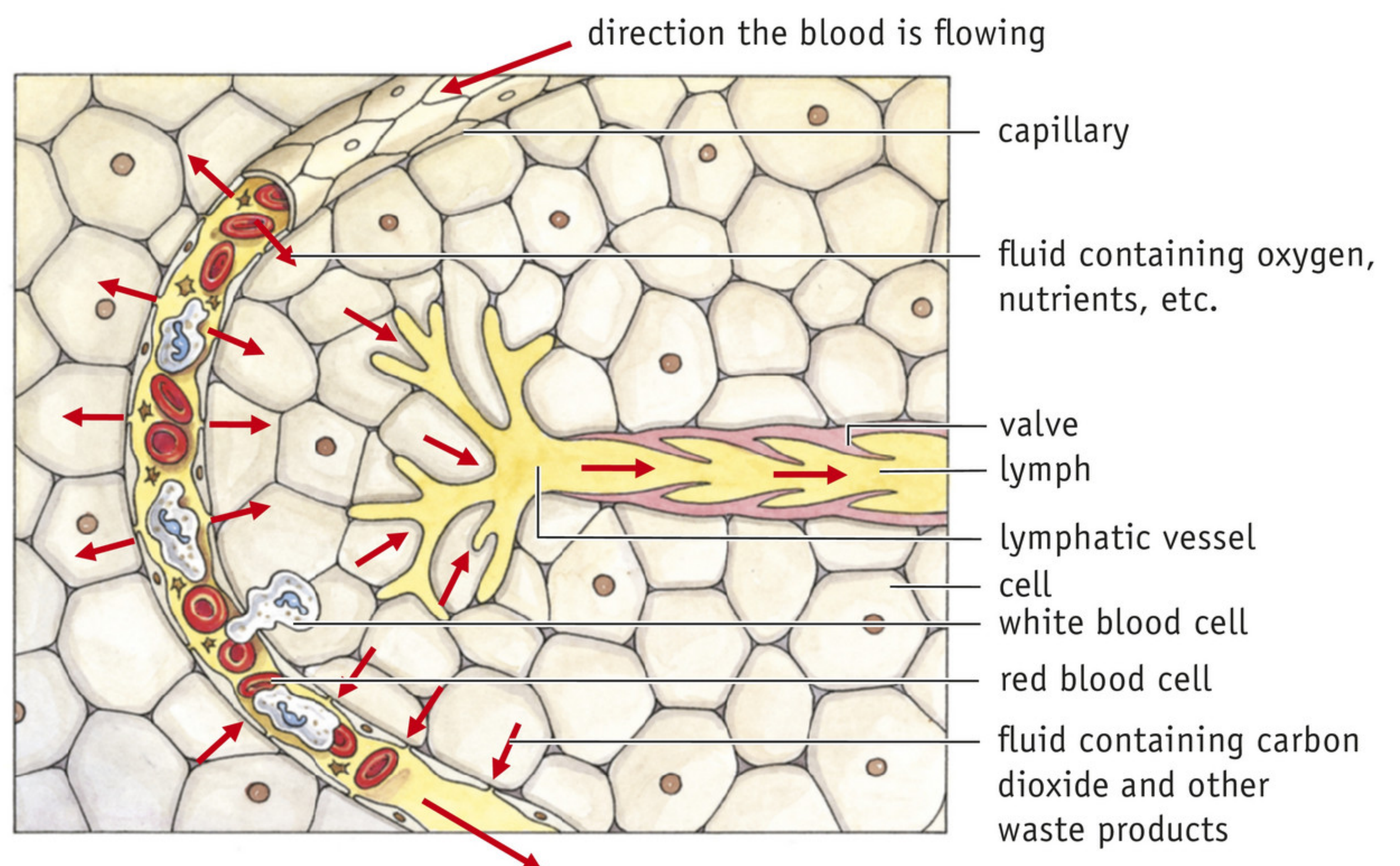
Short-term effects of cannabis include elevated pulse rate, reduced blood pressure, headaches, dizziness, drowsiness, anxiety, and concentration and memory problems.

Long-term effects of cannabis include addiction, insomnia, depression and concentration problems. Smoking cannabis can also damage the airways and increase the risk of lung cancer. Cannabis also increases the chance of psychological disorders such as depression, anxiety or schizophrenia (a mental disorder characterised by failure to recognise what is real).

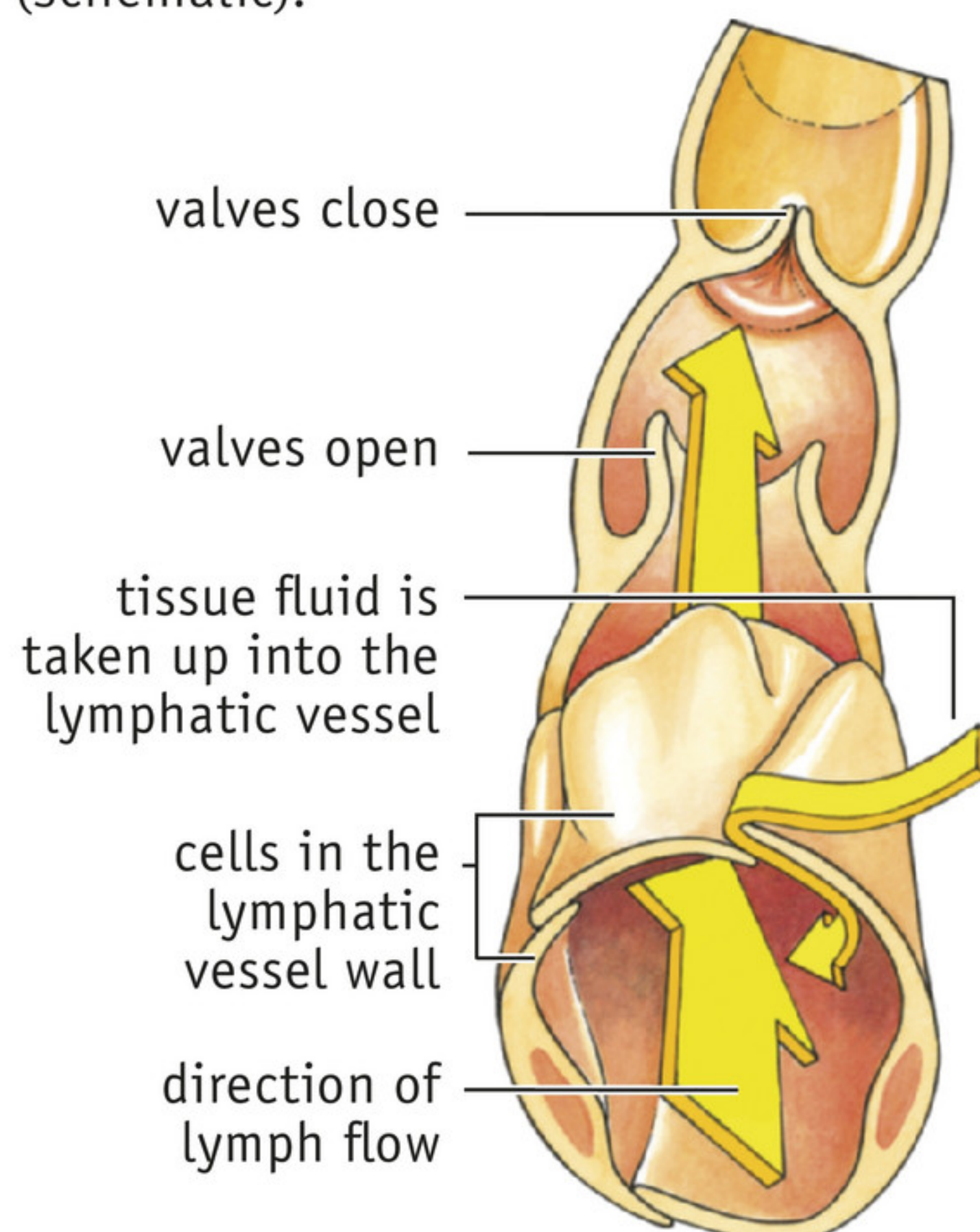
9 Tissue fluid and lymph

Blood pressure pushes fluid out through the walls at the start of the capillaries. This fluid contains dissolved oxygen and nutrients. Cells absorb some of the oxygen and nutrients. The fluid outside the capillaries is known as **tissue fluid**. Tissue fluid can be found between the cells of the organs. Tissue fluid also contains carbon dioxide and other waste products from cells. Tissue fluid is partially reabsorbed by the capillaries (see figure 56).

▼ **Fig. 56** Part of an organ with a capillary, cells and a lymphatic vessel (schematic).



▼ **Fig. 57** Lymphatic vessel (schematic).

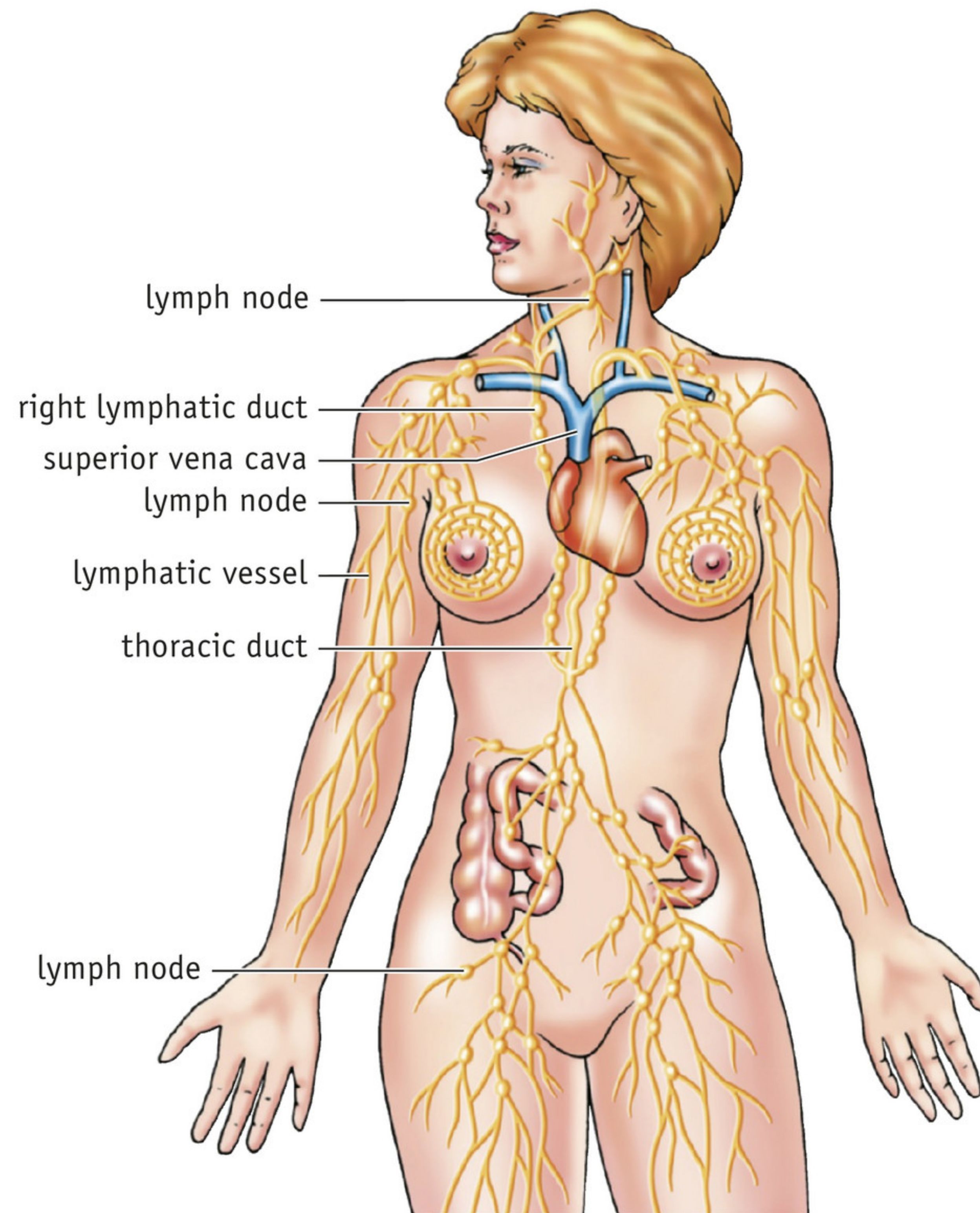


LYMPH AND LYMPHATIC VESSELS

Tissue fluid not absorbed by capillaries ends up in small **lymphatic vessels** (see figure 57). The fluid in lymphatic vessels is known as **lymph**. Lymph consists of water with dissolved substances and white blood cells. Lymph transports carbon dioxide and other waste products away. Lymph also contains the oxygen and nutrients that were not absorbed by cells. The lymphatic vessels carry the lymph away from the cells in the organs. Valves inside the lymphatic vessels only let the lymph flow in one direction.

Various small lymphatic vessels converge into larger lymphatic vessels. All the lymphatic vessels together form the **lymphatic system** (see figure 58). Eventually all lymph ends up in two large lymphatic vessels: the **right lymphatic duct** and the **thoracic duct**. These both drain into the veins located below the collarbones (subclavian veins). The lymph goes through these veins to the superior vena cava.

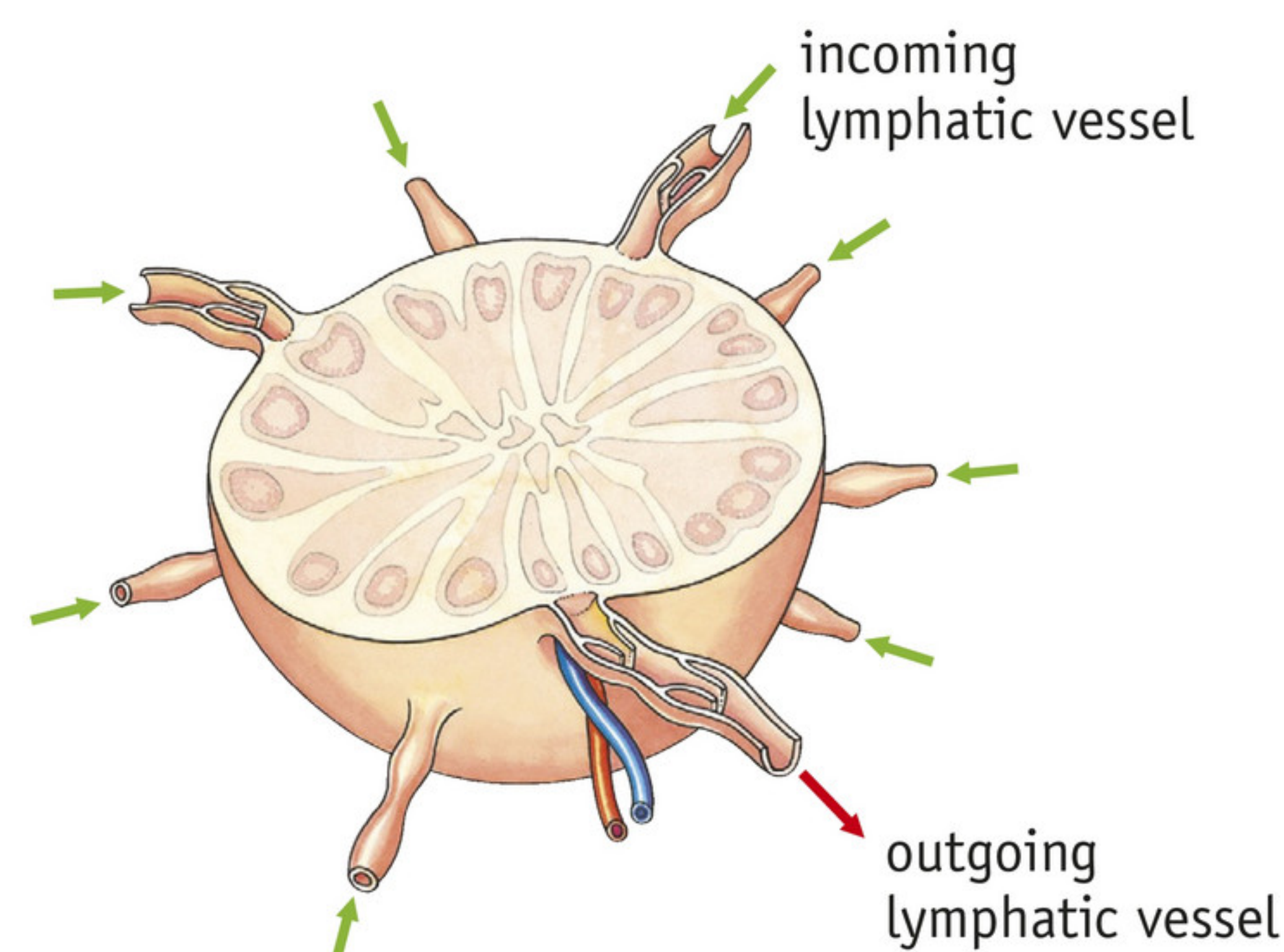
► **Fig. 58** The lymphatic system (schematic).



Lymph nodes are located in certain areas of the body: the neck, armpits and the groin (see figure 59). These lymph nodes purify the lymph, for instance by removing pathogens.

WB EXERCISE 38, PAGE 125

► **Fig. 59** A lymph node (cross-section, schematic).



10 Blood groups and blood transfusions

▼ Fig. 60 Giving blood.

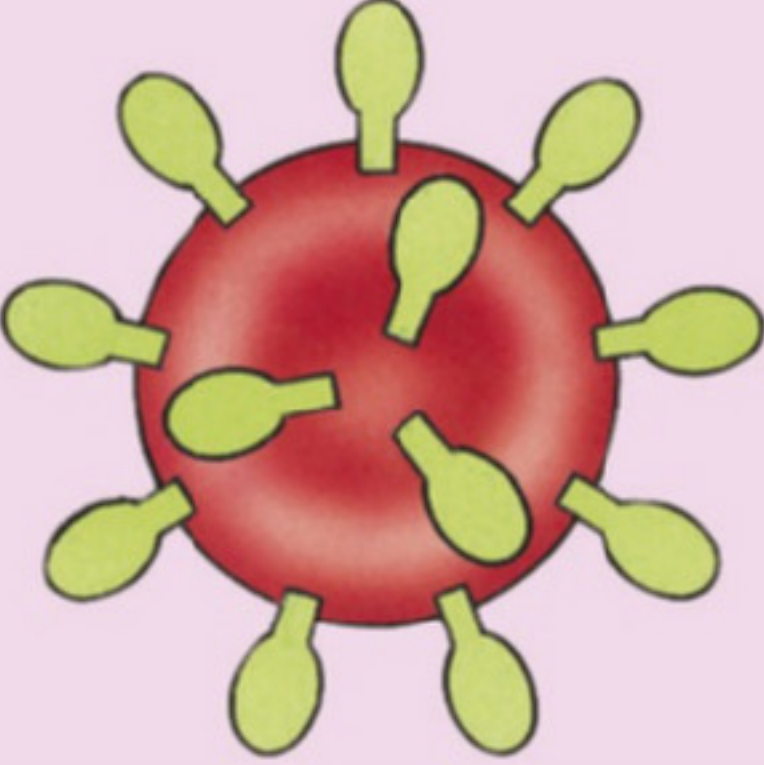
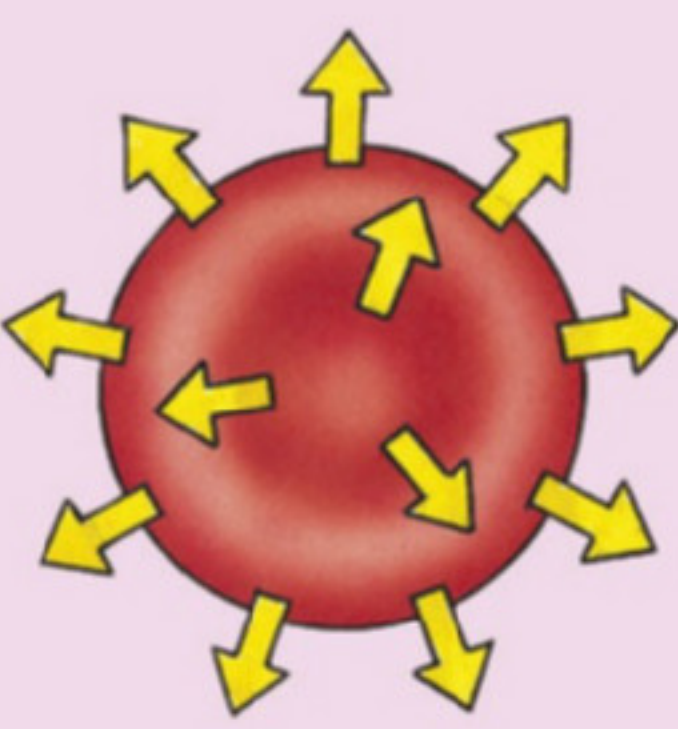
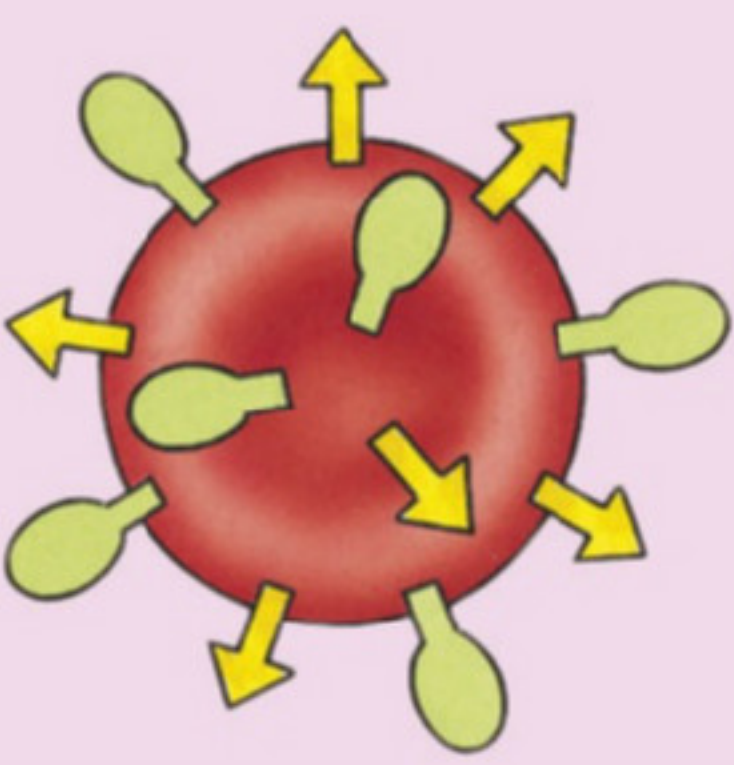
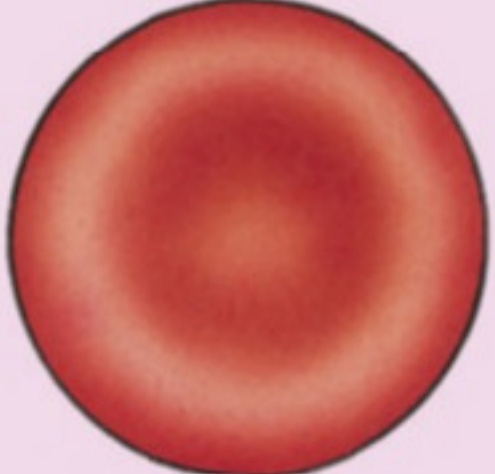


In basics 7, you learned that certain types of white blood cells make antibodies against pathogens. Antibodies can also be found in blood plasma. Research has shown that blood plasma can also contain antibodies against the blood of other humans, and that everyone has blood of a specific **blood group** (also called a blood type). The blood group is important in blood transfusions and donation (see figure 60).

BLOOD GROUPS

The cell membranes of red blood cells carry substances that can act as foreign bodies (antigens) in people who do not have them. These substances are known as **blood factors**. There are lots of kinds of blood factors. Two important blood factors are **antigen A** and **antigen B**. Someone with blood group A has antigen A. This person's blood plasma will have antibodies against antigen B, anti-B. Someone with blood group B has antigen B. This person's blood plasma has antibodies against antigen A, anti-A. Someone with blood group AB has antigens A and B. This person therefore has antibodies to neither factor in their blood plasma. Someone with blood group O has no antigens and therefore has both anti-A and anti-B. Figure 61 shows an overview of the blood groups and antibodies.

▼ Fig. 61 Blood factors (antigens) and antibodies in the various blood groups.

	Blood group A	Blood group B	Blood group AB	Blood group O
Blood factors on red blood cells	antigen A 	antigen B 	antigen A and B 	no antigen A no antigen B 
Antibodies in blood plasma	anti B 	anti A 	no anti-A no anti-B	anti-A anti-B 
% in the Netherlands	43%	9%	3%	45%

▼ Fig. 62 Blood transfusion.



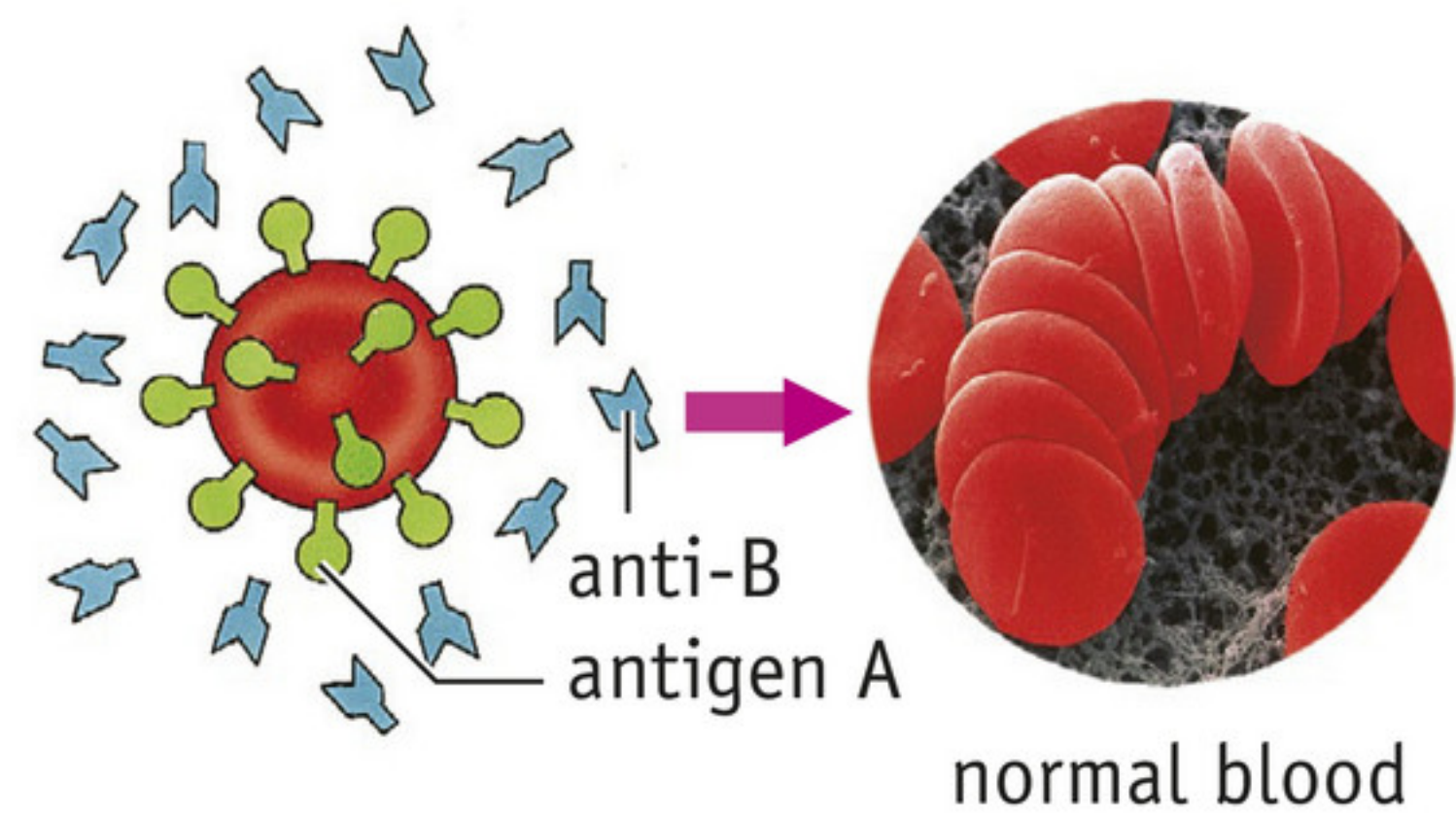
BLOOD TRANSFUSIONS

Someone who has lost a lot of blood in an accident may be given the blood of another person (a **donor**). We call that a **blood transfusion** (see figure 62). In blood transfusions, it is important to know which blood group the **recipient** belongs to and which blood group the **donor blood** is.

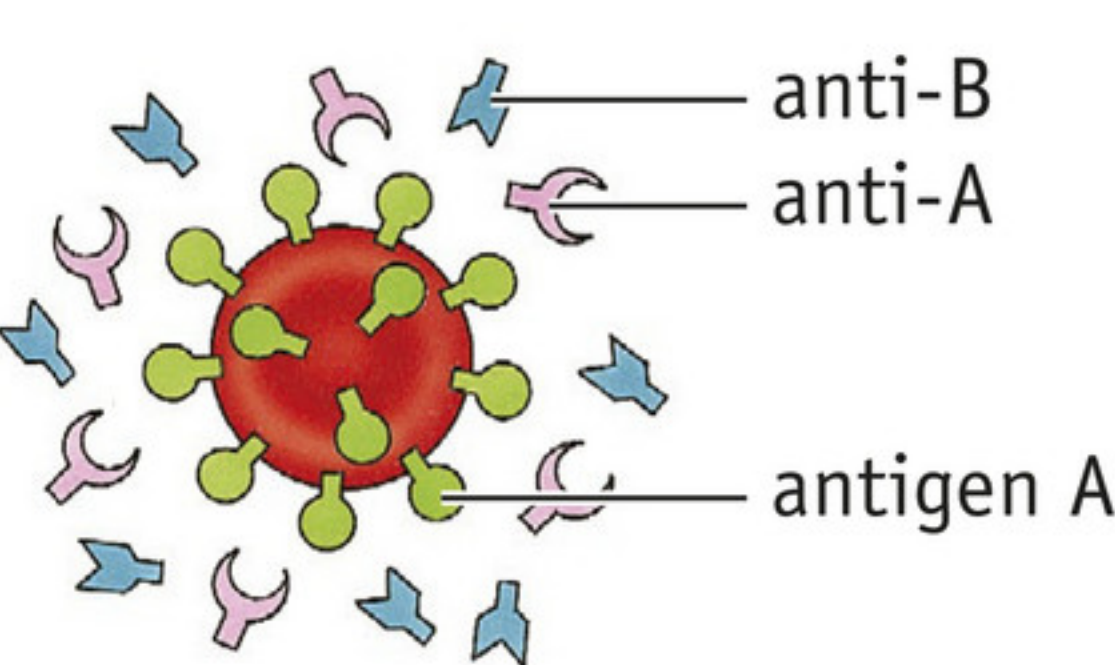
If blood plasma with anti-A comes into contact with red blood cells with antigen A, the red blood cells will clump together (see figure 63). The same happens when blood plasma with anti-B comes into contact with red blood cells with antigen B. The clumps of blood cells get stuck in the capillaries. This can damage the brain and kidneys. The red circles in figure 64 show when a blood transfusion is successful; the other combinations make the red blood cells clump together, which will be the end of them.

WB EXERCISES 39 TO 42, PAGE 126

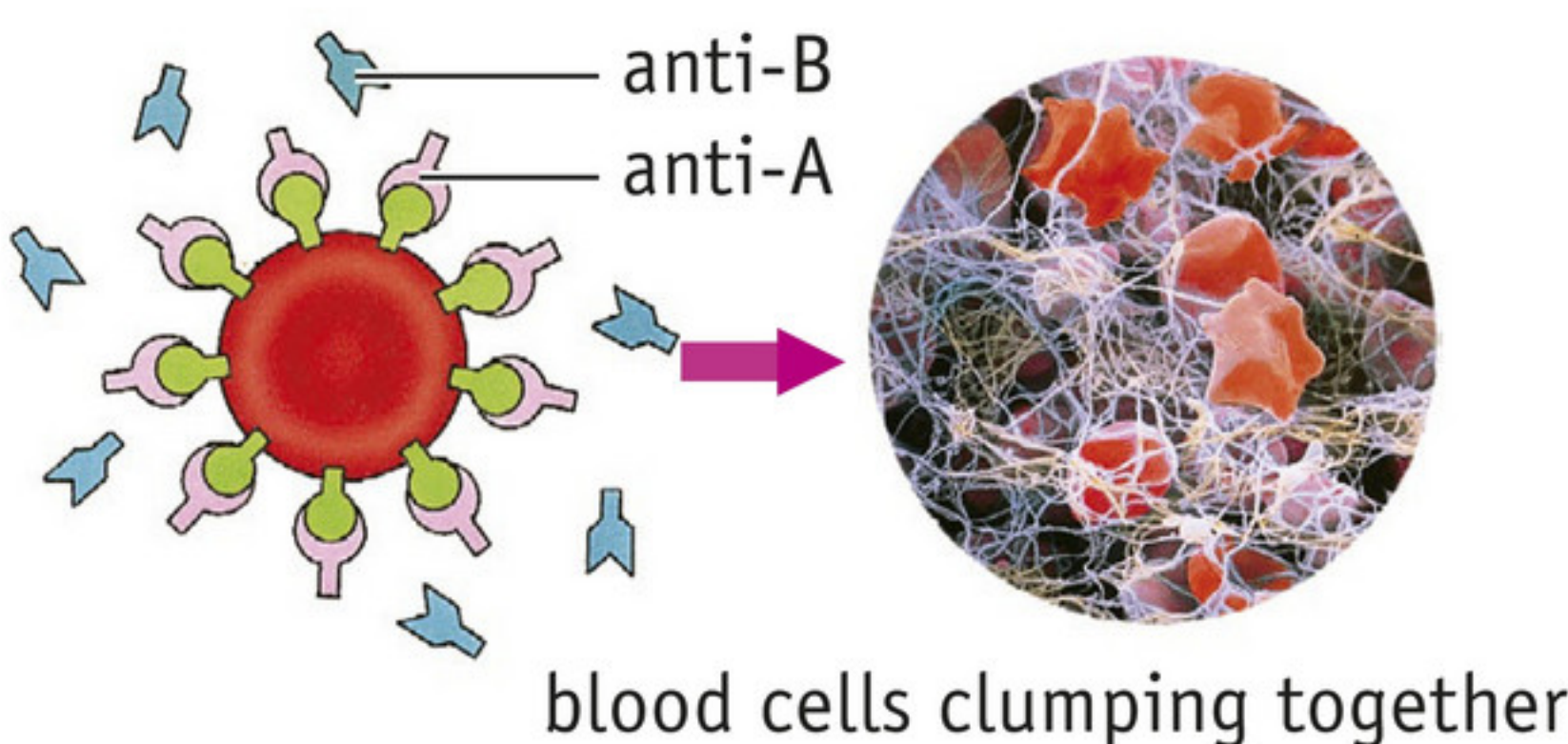
▼ Fig. 63 Red blood cells clumping together.



1 donor blood (blood group A) before the transfusion



2 the blood is donated to someone with anti-A in the blood plasma



3 anti-A from the recipient's blood reacts with antigen A from the donor blood: the donor blood cells start clumping together

► Fig. 64 Table of blood transfusions.

		Blood group of the donor			
		A	B	AB	O
Blood group of the patient (recipient)	A				
	B				
	AB				
	O				

Summary

OBJECTIVE 1

You must be able to name the components that make up blood and their features and functions.

- Blood consists of blood plasma ($\pm 55\%$), and blood cells and platelets ($\pm 45\%$).
- Blood plasma: water with plasma proteins (e.g. fibrinogen) and dissolved substances (e.g. salts).
 - Blood plasma transports oxygen (to a small extent), nutrients, antibodies, carbon dioxide and other waste products.
 - Fibrinogen plays a role in clotting.
- Red blood cells
 - Cells without nuclei.
 - Red cells contain the red pigment haemoglobin.
 - Function: transporting oxygen.
 - Anaemia: the blood does not have enough haemoglobin. This can make you feel weak and tired all the time.
Possible cause: the food does not contain enough iron (iron is needed for producing haemoglobin).
- White blood cells
 - Cells with nuclei.
 - White blood cells do not have a fixed shape: they can squeeze through the walls of capillaries.
 - Function: defence against pathogens, for example by engulfing and digesting bacteria.
 - Pus: dead white blood cells with the bacteria they killed.
- Platelets.
 - Fragments of cells that have broken up, with no nuclei.
 - Function: clotting.
 - Thrombus: a clot within a blood vessel. This can block the blood vessel.

OBJECTIVE 2

You have to know the differences between and functions of the pulmonary circulation and systemic circulation in the human double circulatory system.

- Double circulatory system: in each complete circuit, the blood passes through the heart twice.
- Pulmonary circulation: heart – lungs – heart.
 - Function: absorbing oxygen into the blood and releasing carbon dioxide to the air.
- Systemic circulation: heart – rest of the body – heart.

- Function: carrying oxygen and nutrients to the cells, and absorbing carbon dioxide and other waste products into the blood.

OBJECTIVE 3

You have to be able to name the parts of the heart and the blood vessels connected to them, and their features and functions.

Parts	Characteristics and functions
Superior and inferior vena cava	– transports deoxygenated blood from the organs back to the heart
Right atrium	– receives blood that is low in oxygen from the vena cava and passes it through to the right ventricle – the wall is less muscular
Right ventricle	– pumps blood that is low in oxygen into the pulmonary artery – the wall is muscular
Pulmonary artery	– transports blood that is low in oxygen from the heart to the lungs
Pulmonary veins	– transport oxygenated blood from the lungs to the heart
Left atrium	– receives oxygenated blood from the pulmonary veins and passes it to the left ventricle – the wall is less muscular
Left ventricle	– pumps oxygenated blood into the aorta – the wall is very muscular
Aorta	– transports oxygenated blood from the heart to the organs
Septum	– separates the left and right halves of the heart
Atrioventricular valves	– valves between the atria and the ventricles – prevent blood flowing back from the ventricles to the atria
Semilunar valves	– valves at the start of the pulmonary artery and the aorta – prevent blood flowing back from the pulmonary artery and aorta into the ventricles.
Coronary arteries	– branches coming off the aorta – transport blood that is rich in oxygen and nutrients (including glucose) to the heart muscle
Coronary veins	Carry blood that is rich in carbon dioxide and other waste products away from the heart muscle

OBJECTIVE 4

You must be able to describe the three phases of the cardiac cycle.

- Contraction of the atria.
 - The atria contract. This makes blood flow into the ventricles.
 - The atrioventricular valves are open, the semilunar valves are closed.
- Contraction of the ventricles.
 - The ventricles contract.
 - The atrioventricular valves close.
 - The pressure in the ventricles increases.
 - The semilunar valves open.
 - The blood gets pumped into the pulmonary arteries and the aorta.
- Cardiac pause.
 - Both the atria and the ventricles relax.
 - Blood flows from the vena cava and pulmonary veins into the atria and ventricles.
 - The atrioventricular valves are open, the semilunar valves are closed.

OBJECTIVE 5

You must be able to name three types of blood vessels and their characteristics and functions.

- Arteries:
 - blood flows through them away from the heart;
 - high blood pressure;
 - thick, tough and elastic walls;
 - noticeable 'pulse', e.g. in the wrists;
 - usually located deeper inside the body;
 - the only valves are the semilunar valves (at the start of pulmonary artery and the aorta).
- Capillaries:
 - walls one cell layer thick;
 - white blood cells and fluid with oxygen, nutrients and waste products (e.g. carbon dioxide) can get through the walls.
- Veins:
 - blood flows through them back towards the heart;
 - low blood pressure;
 - thin walls;
 - no noticeable 'pulse';
 - usually lie nearer the surface of the body.
 - valves keep the blood from flowing back (especially in the arms and legs).

OBJECTIVE 6

You must be able to name arteries and veins in the human circulatory system.

- Pulmonary circulation: pulmonary arteries – pulmonary veins.
 - deoxygenated blood flows through pulmonary arteries.
 - oxygenated blood flows through pulmonary veins.
- Systemic circulation: aorta – brachial arteries – brachial veins – carotid arteries – jugular veins – hepatic artery – hepatic vein – intestinal artery – portal vein – renal arteries – renal veins – femoral arteries – femoral veins – inferior vena cava – superior vena cava.
 - Oxygenated blood flows through arteries.
 - Deoxygenated blood flows through veins.
 - Deoxygenated blood flows from the walls of the intestinal tract through the portal vein to the liver.

OBJECTIVE 7

You must be able to name the causes and effects of cardiovascular diseases. You must also be able to show how you can reduce the risk of getting cardiovascular diseases.

- Blood pressure abnormalities.
 - People with low blood pressure suffer headaches and dizziness more often.
 - High blood pressure increases the risk of getting cardiovascular diseases.
- Atherosclerosis: narrowing of the blood vessels.
 - Cause: in particular, high blood cholesterol levels can create a fatty layer (with cholesterol and calcified deposits) on the inner walls of blood vessels.
 - Consequence: reduced blood supply to the organs and possible overexertion of the heart.
- Heart attack: part of the heart muscle is no longer being supplied with oxygen and nutrients.
 - Cause: a coronary artery – or a branch coming off one of them – has been blocked (usually by atherosclerosis).
 - Consequence: part of the heart muscle dies off. This can be fatal.
- Stroke: a blood vessel in the brain has been blocked by atherosclerosis or a blood clot. The brain tissue beyond the blockage is no longer being supplied with oxygen and nutrients.
- Angioplasty: the narrowed coronary artery is widened with a kind of balloon. A stent is then often put in place that keeps the coronary artery open.
- You can reduce the risk of getting cardiovascular diseases by adopting a healthy lifestyle.

- Not smoking.
- Not drinking alcohol (adults: moderate drinking).
- Eating a healthy and varied diet (with few fatty foods and not much salt).
- Getting regular exercise (at least half an hour per day).
- Having a healthy bodyweight.
- Hereditary factors play a role in whether you get cardiovascular diseases.

OBJECTIVE 8

You must be able to name the parts of the kidneys and urinary tract and their features and functions.

- Kidneys: consist of (starting from the outside) the renal cortex, renal medulla and renal pelvis.
 - Function: removing waste products, excess water, excess salts and harmful substances from the blood. The eliminated substances together are called urine.
 - The renal cortex and renal medulla produce the urine.
 - The urine is collected in the renal pelvis.
- Ureters: transport the urine from the kidneys to the bladder.
- Bladder: urine is held here temporarily.
- Urethra: discharges urine from the body.

OBJECTIVE 9

You must be able to describe how antibodies protect against infections, and how immunity can occur.

- Antigen (foreign bodies): substances that do not belong in the body.
 - There are antigens on the surface of pathogens.
- Infection: pathogens enter the body.
 - A certain type of white blood cell produces antibodies against the pathogen's antigens.
 - Antibodies attach themselves to antigens on the surface of the pathogen. The pathogen gets covered with antibodies. This disables the pathogen.
 - Any given type of antibody can only attach itself to one type of antigen.
- Immunity: antibodies against the pathogen stay in the blood after an infection, or can be produced again quickly when a new infection occurs. Symptoms of illness do not appear.
 - Natural immunity: arises when a person suffers an illness, such as chickenpox, for example.
 - Artificial immunity: provided through vaccination. A vaccine contains a dead or weakened pathogen.

OBJECTIVE 10

You must be able to show what blood alcohol content (BAC) is. You must also be able to name several short-term and long-term consequences of alcohol consumption.

- Blood alcohol content (BAC): amount of alcohol in the blood as a permillage.
 - One permille (‰) of alcohol: one milligram of alcohol per millilitre of blood. A permillage of 0.5 means that 1 litre of blood contains 0.5 grams of pure alcohol.
- A few short-term consequences of alcohol consumption:
 - 1 to 3 drinks: relaxation (0 to 0.5‰); quickened pulse and breathing rate; the blood vessels expand; reduced senses of taste, smell and sight; reduced sense of pain;
 - 3 to 7 drinks: tipsy (0.5 to 1.5‰); overconfidence; reduced inhibitions; impaired memory; poor muscle coordination and reaction time; impaired judgement of situations;
 - 7 to 15 drinks: drunk (1.5 to 3‰); self-criticism disappears; heightened emotions; face gets red or swollen; pupils dilate; nausea;
 - 15 to 20 drinks: stupor (3 to 4‰); senses are numbed;
 - 20 to 25+ drinks: unconsciousness (4‰ and above); slow breathing rate and pulse; risk of coma and death by respiratory or cardiac arrest.
- Hangover: headache and thirst after consuming too much alcohol.
- Binge drinking: drinking lots of alcohol in a short period of time, making the blood alcohol level quickly rise above 0.8 permille.
- A few long-term consequences of alcohol consumption:
 - performing less well at school, in your studies and at work;
 - damage to the liver, brain, stomach and heart;
 - memory loss.

OBJECTIVE 11

You must be able to name several short-term and long-term effects of cannabis consumption.

- The active ingredient of cannabis: THC.
- Short-term effects include: elevated pulse rate, reduced blood pressure, headaches, dizziness, drowsiness, anxiety, and concentration and memory problems.

- Long-term effects: addiction, insomnia, depression, concentration problems, damage to airways, lung cancer and psychological disorders (depression, anxiety or schizophrenia).

EXTRA OBJECTIVE 12

You must be able to name the characteristics and function of tissue fluid and lymph.

- Tissue fluid: created when the blood pressure (in the systemic circulation) pushes fluid out of the capillaries. This transports oxygen and nutrients to the cells, and carries away carbon dioxide and other waste products. Also contains white blood cells.
- Lymph: tissue fluid absorbed into the lymphatic vessels. Contains white blood cells, oxygen, nutrients, carbon dioxide and other waste products.
 - Small lymphatic vessels converge to produce large lymphatic vessels. Lymphatic vessels have valves.
 - The lymphatic system transports the lymph back to the circulatory system through the right lymphatic duct and thoracic duct.
 - Lymph nodes purify the lymph, for instance by removing pathogens.

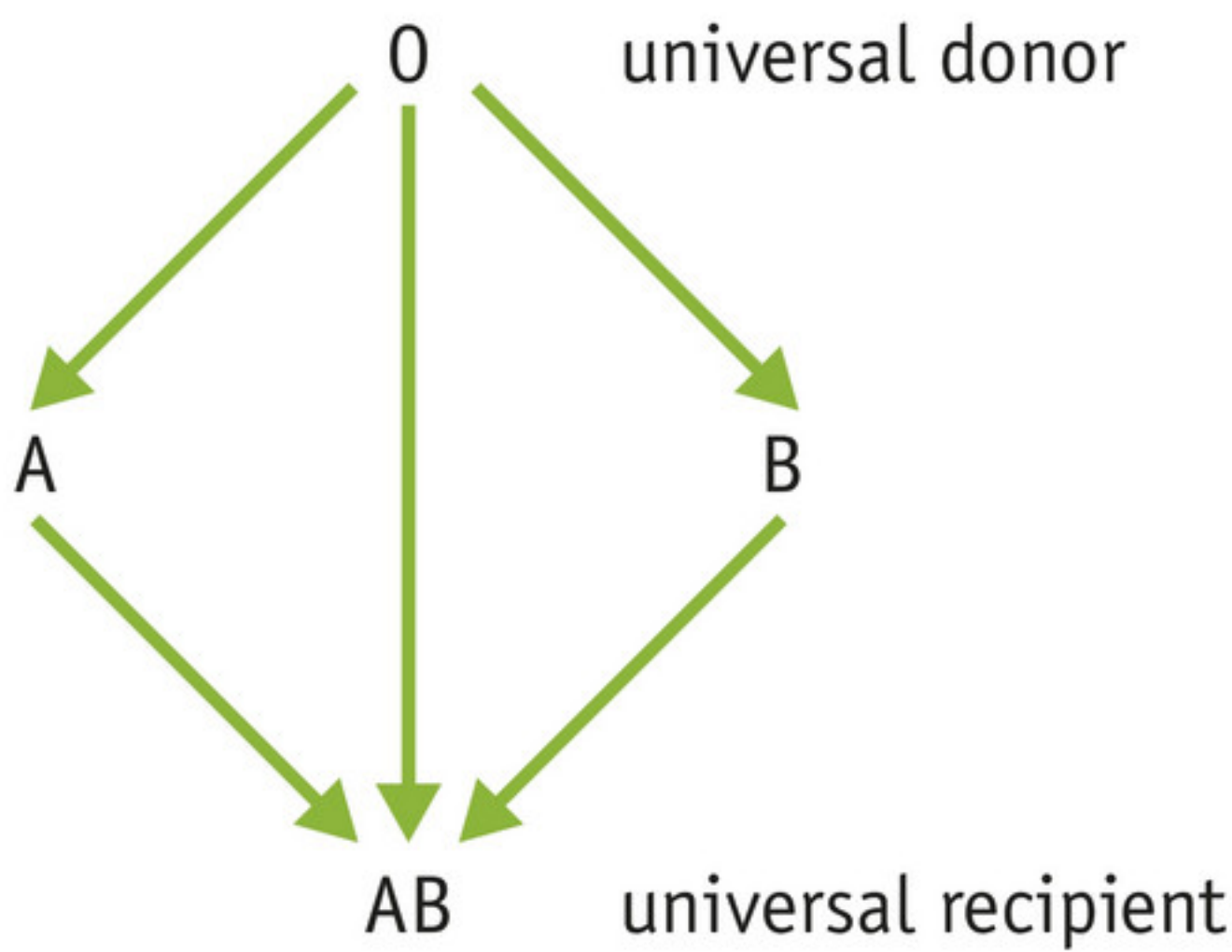
EXTRA OBJECTIVE 13

You must be able to describe how blood groups differ and what role they play in blood transfusions.

- Blood groups (A, B, AB, O) differ in terms of blood factors and antibodies.
 - Blood factor: substance on the cell membrane of red blood cells that is seen as a foreign body (antigen) by someone who does not have that substance on their own cells.
 - Important blood factors are antigen A and antigen B.
 - The blood plasma contains antibodies to the antigens that are not on the body’s own red blood cells.

Blood group	Blood factor on red blood cells	Antibodies in blood plasma
A	antigen A	anti-B
B	antigen B	anti-A
AB	antigen A and antigen B	none
o	none	anti-A and anti-B

- Blood transfusion: giving blood to another person.
 - Possible blood transfusions:



- In other cases, the antibodies of the recipient react to the antigen in the donor blood (e.g. anti-A with antigen A). Red blood cells clump together and die.

SKILLS AND COMPETENCIES

BASICS

- You have practised using the microscope.
- You have practised making drawings.
- You have practised making a pie chart.
- You have practised reading and making a chart.
- You have practised getting information from articles and brochures.
- You have practised reading and making a table.

EXTRA

- You have learned how to read and complete a blood transfusion chart.

The diagnostic test does not include any questions about the competencies/skills printed in *italics*.

You have met an A&E nurse and a cardiologist in this unit. You have also seen applications in science and daily practice that use the material from this unit.

Diagnostic test

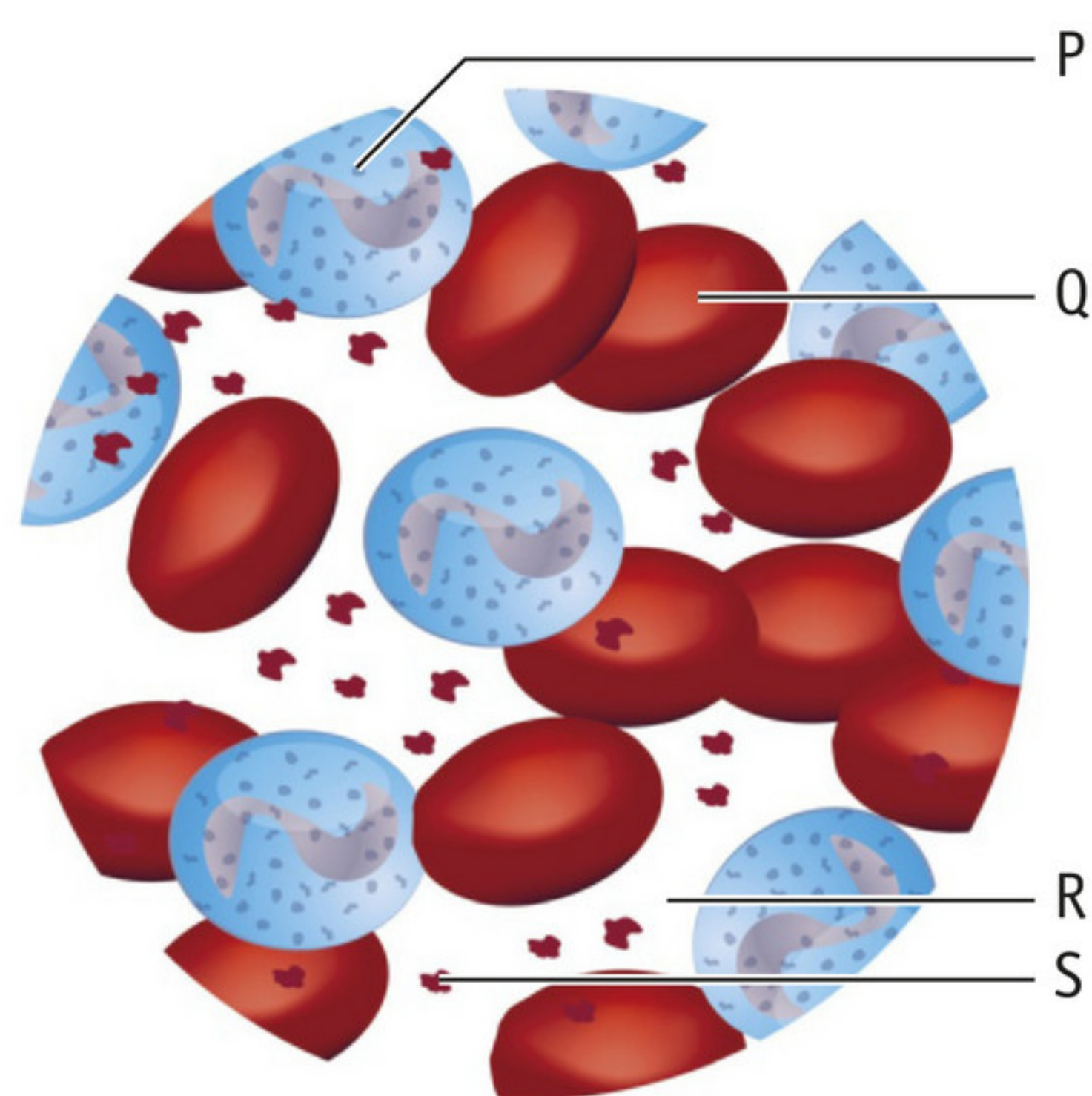
You can use this test to check for yourself whether you understand and can apply the objectives listed in the summary. Write down the answers on the score sheet in your workbook.

OBJECTIVE 1

Answer the following questions.

Figure 65 is a drawing of human blood seen through a microscope. Four components of blood are labelled P, Q, R and S. Questions 1 to 4 are about this figure.

▼ Fig. 65



- 1 Alcohol is transported in the blood to all parts of the body.
Which of components P, Q, R and S transports most of the alcohol?
- 2 A horseshoe crab has blue blood. Horseshoe crabs are often kept in laboratories where medical research is done (see figure 66). The blue pigment is in a particular part of the blood where humans have a red pigment instead.
Which of the components labelled P, Q, R and S in figure 65 contains this blue pigment?

▼ Fig. 66



- 3 Blood doping increases the amount of one particular component of the blood. Lance Armstrong, seven-time winner of the Tour de France, used blood doping to improve his performance hugely and obtain those seven victories (see figure 67).
Which of components P, Q, R and S was increased in particular? Explain your answer.

▼ Fig. 67



- 4 Figure 68 contains a text from a medical folder. Various components of the blood are involved when thrombosis occurs.
Which components?

▼ Fig. 68

Thrombosis

A thrombosis means a blood vessel is being closed off by blood clots. During long flights and bus journeys, particularly in chairs where there is not much leg room, sitting for a long time can make the blood flow less well, particularly in the legs. This increases the risk of thrombosis occurring. This is called deep vein thrombosis.



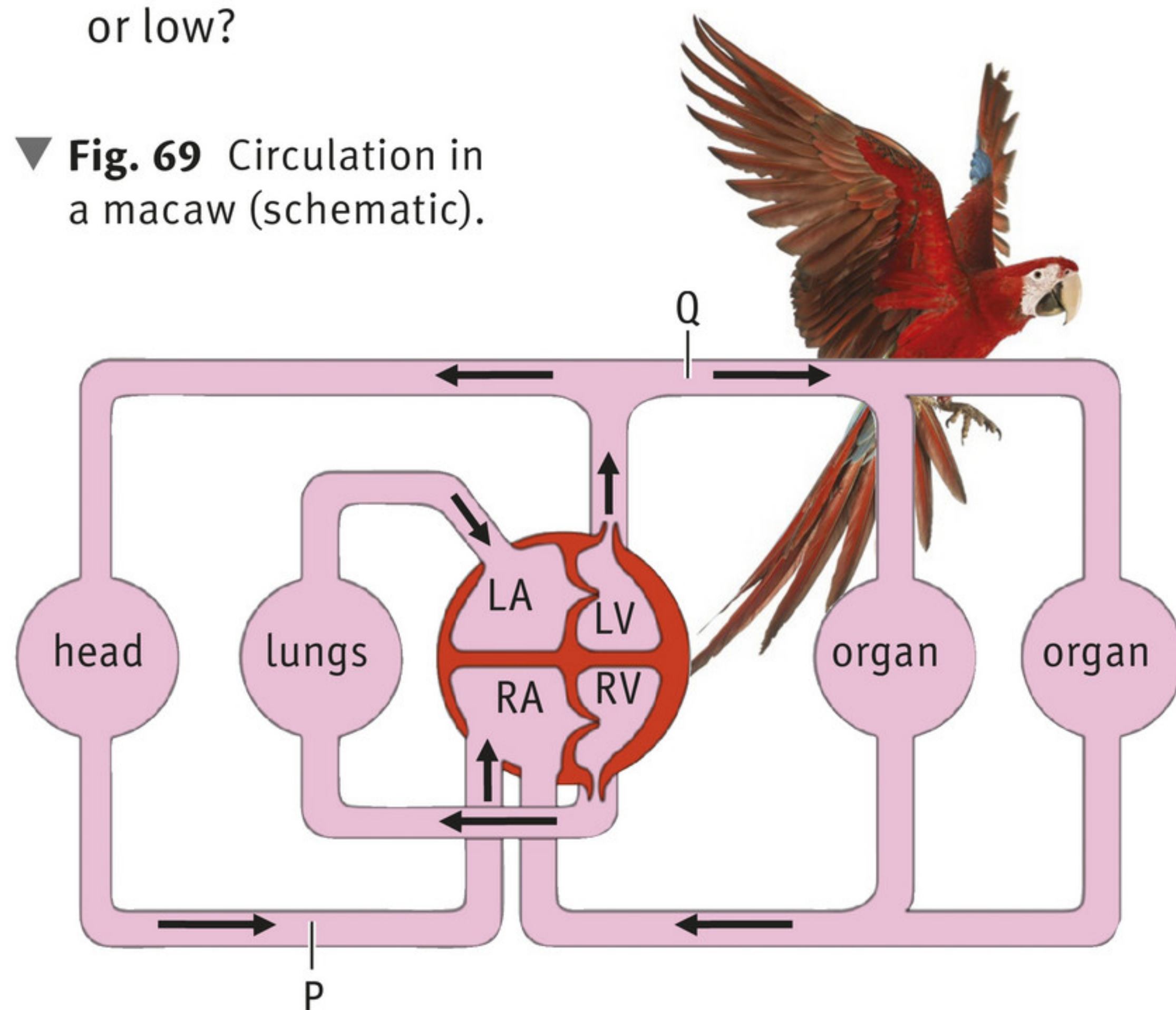
OBJECTIVE 2

Answer the following questions.

Figure 69 is a schematic drawing of the circulation of a macaw.

- 1 A macaw's circulation is a double system (just like a human's).
Explain how you can see that.
- 2 Are the macaw's lungs part of the systemic circulation or the pulmonary circulation?
- 3 Does blood vessel P contain blood that is rich or poor in oxygen?
- 4 Is the level of carbon dioxide in the blood at Q high or low?

▼ Fig. 69 Circulation in a macaw (schematic).



Legend: LA = left atrium
LV = left ventricle
RA = right atrium
RV = right ventricle

- 5 Bluetongue is a viral disease that is dangerous to sheep in particular (see figure 70). The virus is transmitted by small, blood-sucking flies. The bluetongue virus gets through the skin and via the blood into the tongue. A sheep's circulation is the same as a human's.
Does the virus go through the pulmonary circulation on its way from the skin to the tongue? And does it go through the systemic circulation?

▼ Fig. 70 A sheep with bluetongue.

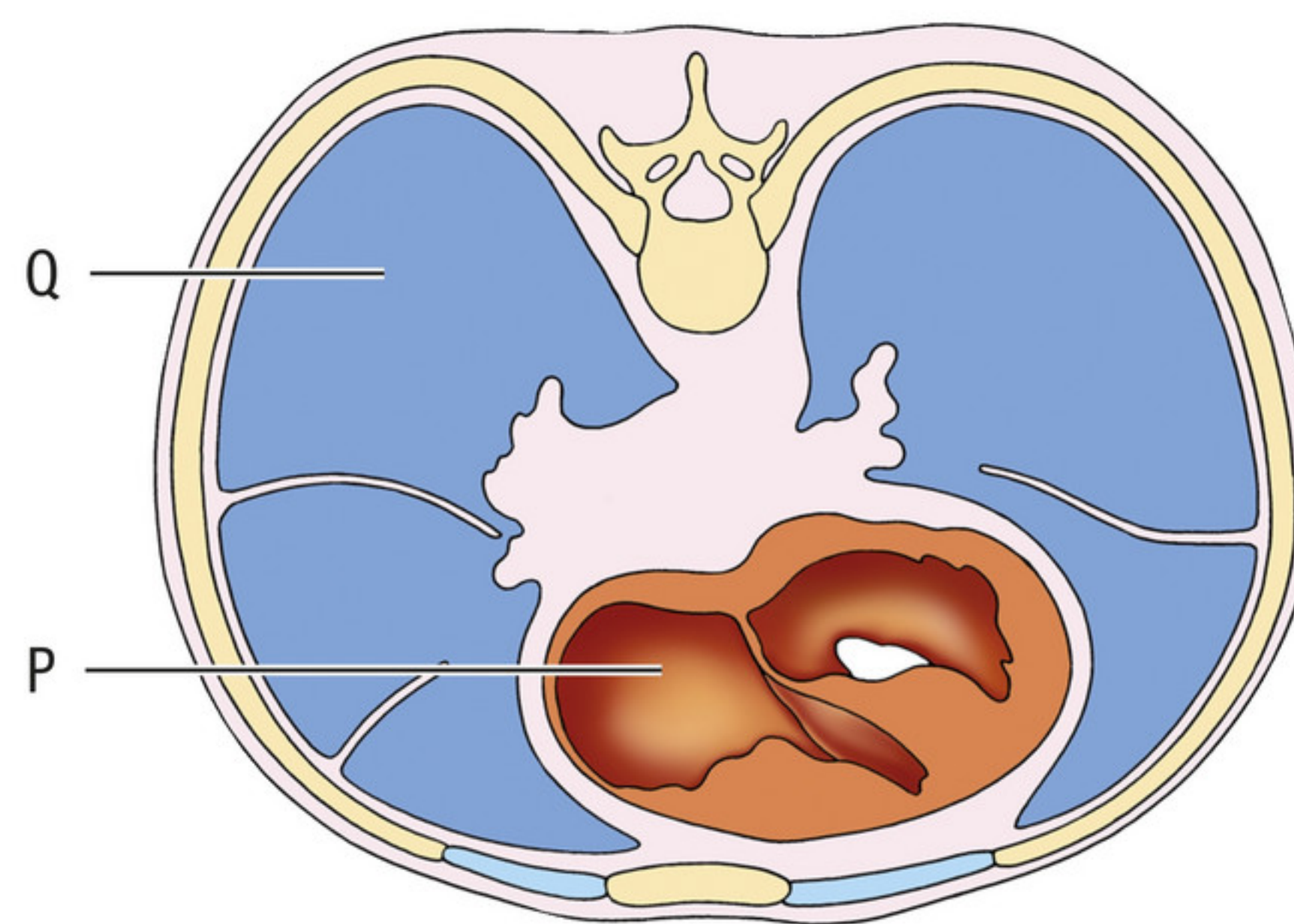


OBJECTIVE 3

Answer the following multiple choice questions.

- 1 Figure 71 shows a schematic diagram of a cross section of a human chest. One half of the heart is labelled P. P is connected to organ Q by a blood vessel. That blood vessel has not been drawn in. Which blood vessel is it?
A Aorta.
B Vena cava.
C Pulmonary vein.
D Pulmonary artery.

▼ Fig. 71



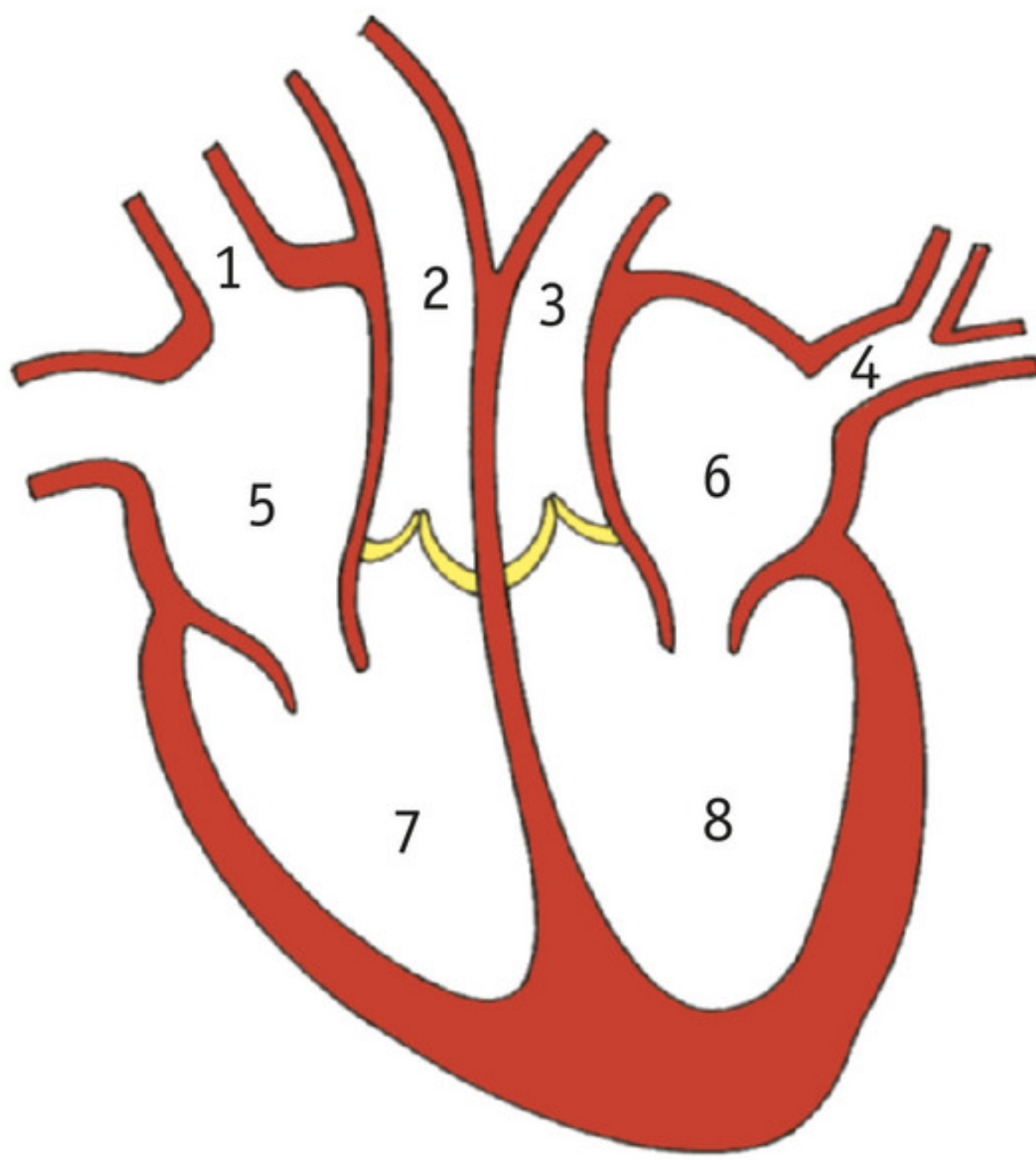
- 2 Figure 72 shows you a number of athletes. Which part of the heart in particular is made stronger in the training done by distance runners?
A The left atrium.
B The left ventricle.
C The right atrium.
D The right ventricle.

▼ Fig. 72



Figure 73 shows a schematic drawing of a cross-section of the heart and its connecting blood vessels. Questions 3 and 4 are about this drawing.

▼ Fig. 73



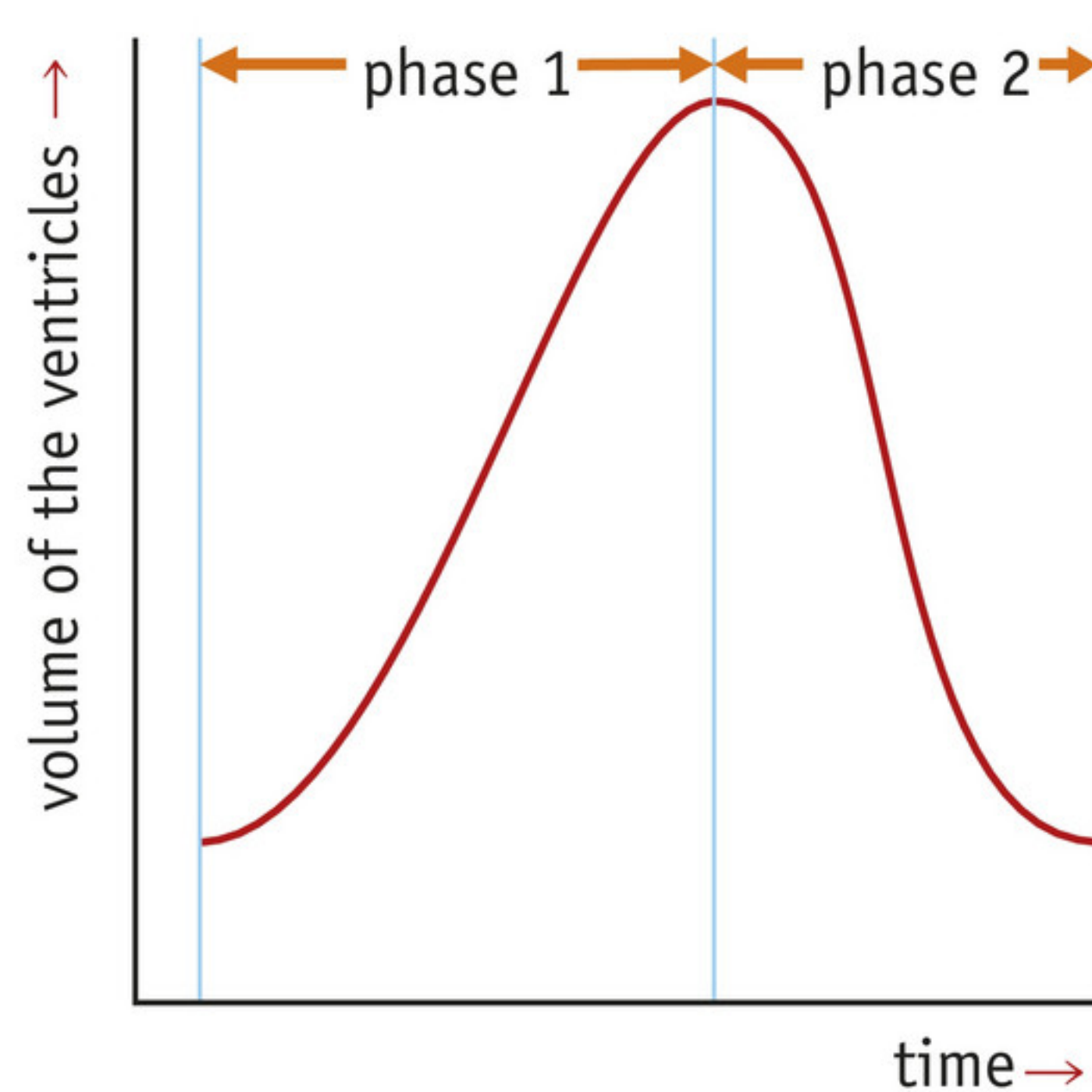
- 3 Which of the numbered blood vessels carries oxygenated blood to the heart?
- A Blood vessel 1.
B Blood vessel 2.
C Blood vessel 3.
D Blood vessel 4.
- 4 Which number is the part of the heart that pumps blood into the aorta?
- A Number 5.
B Number 6.
C Number 7.
D Number 8.

OBJECTIVE 4

Answer the following multiple choice questions.

- 1 Figure 74 contains a graph showing the changes in the volume of the ventricles.
- Which direction is the blood flowing in during phase 2?
- A From the atria to the ventricles.
B From the ventricles to the atria.
C From the ventricles to the pulmonary artery and the aorta.
D From the vena cava and pulmonary veins to the atria.

▼ Fig. 74

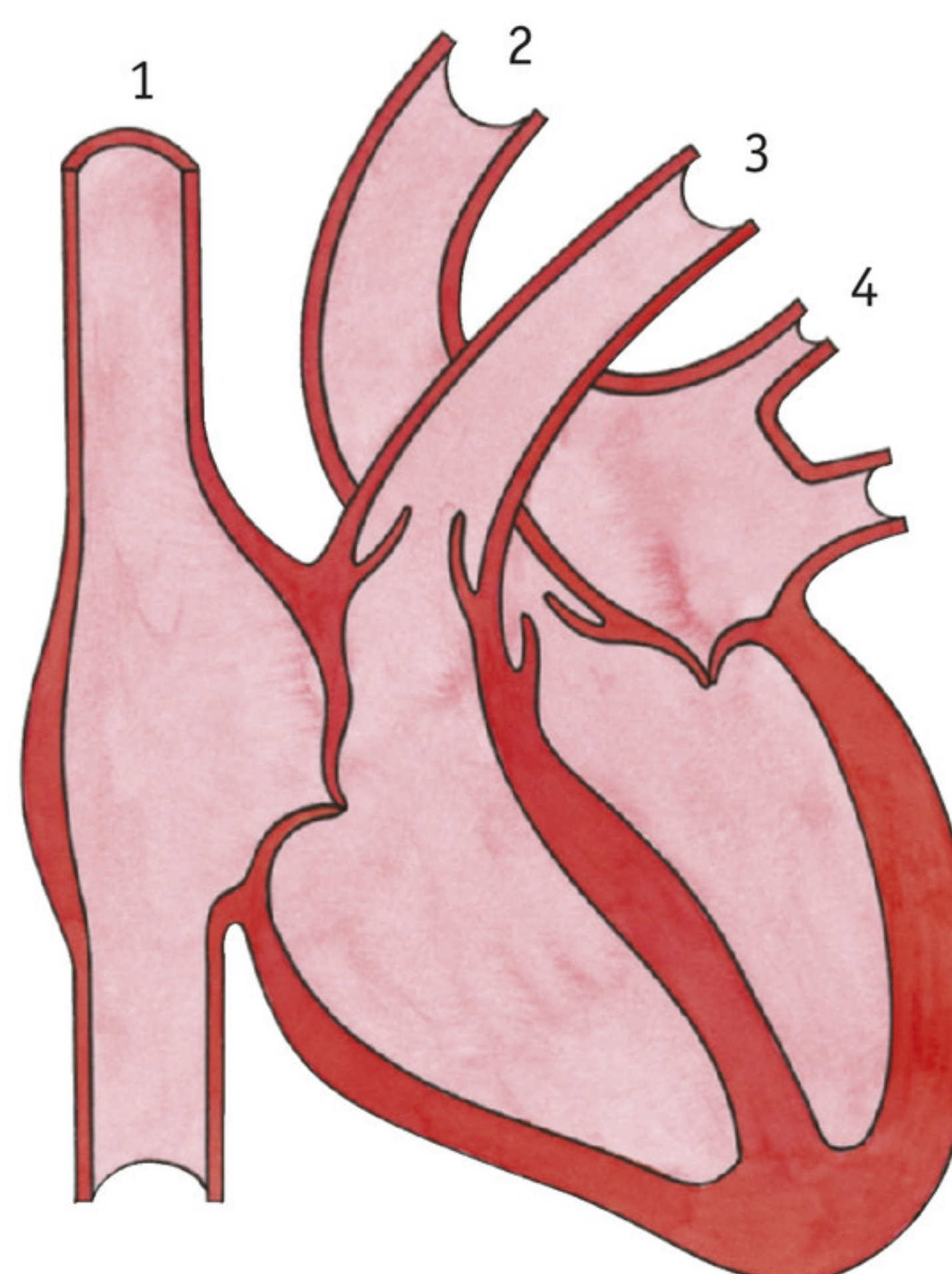


- 2 There are three phases during the cardiac cycle. There are valves between the atria and the ventricles. During which phase or phases are these valves open?
- A Only during the cardiac pause.
B Only during the contraction of the atria.
C Only during the contraction of the ventricles.
D Both during the cardiac pause and during contraction of the atria.

Figure 75 shows a drawing of a section through the heart at a certain stage in the cardiac cycle. Questions 3 and 4 are about this drawing.

- 3 Are the atria of this heart contracting at this point in time, or are they relaxed? What about the ventricles?
- | | <i>The atria</i> | <i>The ventricles</i> |
|---|------------------|-----------------------|
| A | are contracted. | are contracted. |
| B | are contracted. | are relaxed. |
| C | are relaxed. | are contracted. |
| D | are relaxed. | are relaxed. |
- 4 In which of the numbered blood vessels is the blood pressure highest at the moment?
- A In blood vessel 1.
B In blood vessel 2.
C In blood vessel 3.
D In blood vessel 4.

▼ Fig. 75



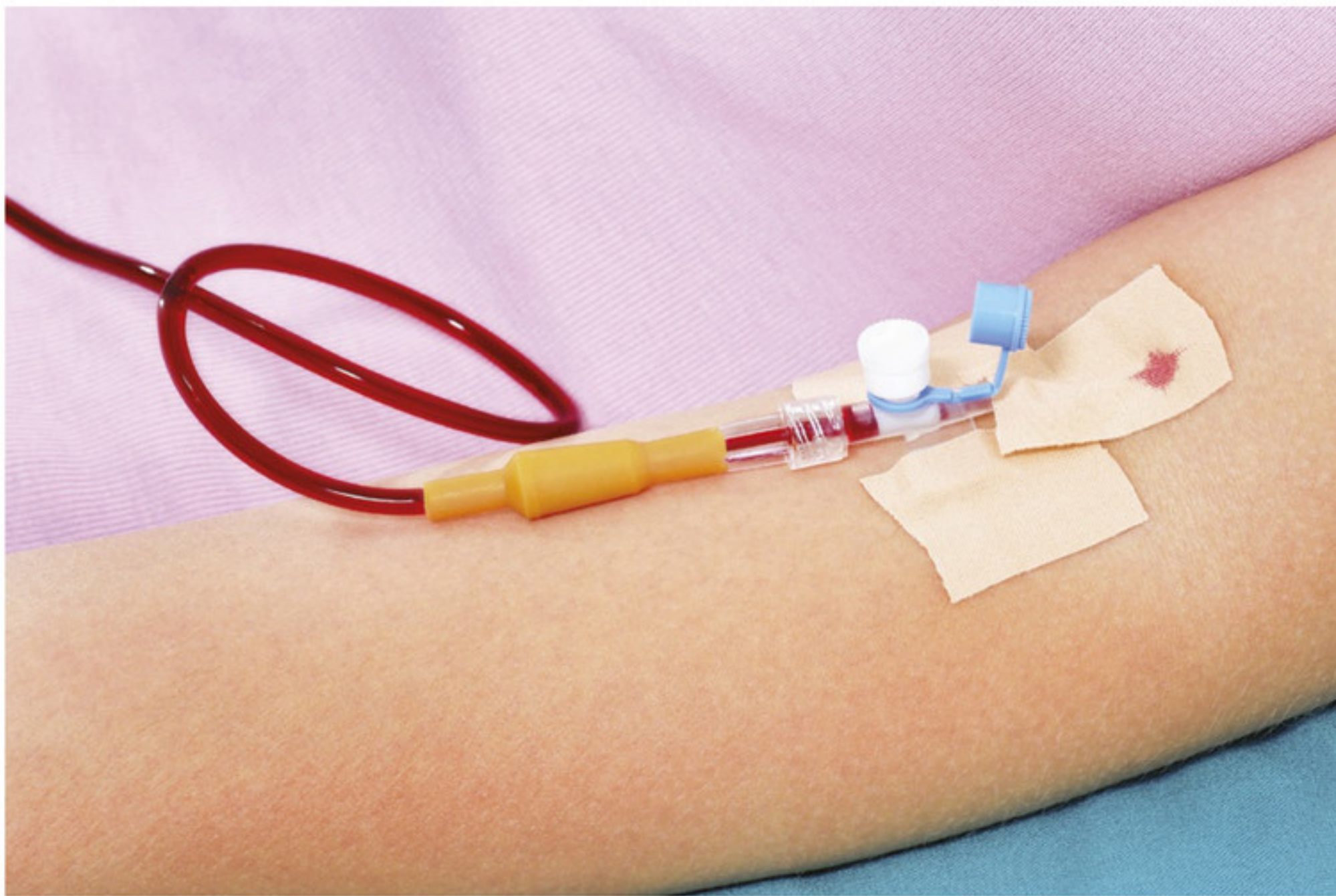
OBJECTIVE 5

Answer the following questions.

Veins, capillaries and arteries are three different types of blood vessels.

- Figure 76 shows a blood transfusion. Which type of vessel is the needle for the blood transfusion inserted into? Explain your answer. Give two reasons.

▼ Fig. 76



- Which of the three types of blood vessels has walls that white blood cells and liquids can get through?
- Figure 77 shows you some blood vessels. Is the blood in these vessels flowing towards the heart or towards the toes?

▼ Fig. 77



- You can feel your pulse in your neck (see figure 78). Explain why someone may faint if hard pressure is exerted on both sides of the neck.

▼ Fig. 78



- Figure 79 shows you an abnormality that is caused in part by the blood not flowing properly. In which type of blood vessels can this abnormality arise? Why isn't the blood flowing properly?
- In the past, a piece of a vein from the leg was generally used for bypass surgery. Nowadays, using a piece of an artery is increasingly common. The structural differences between these two types of blood vessels are one reason for this. State a structural difference between a vein and an artery.

▼ Fig. 79

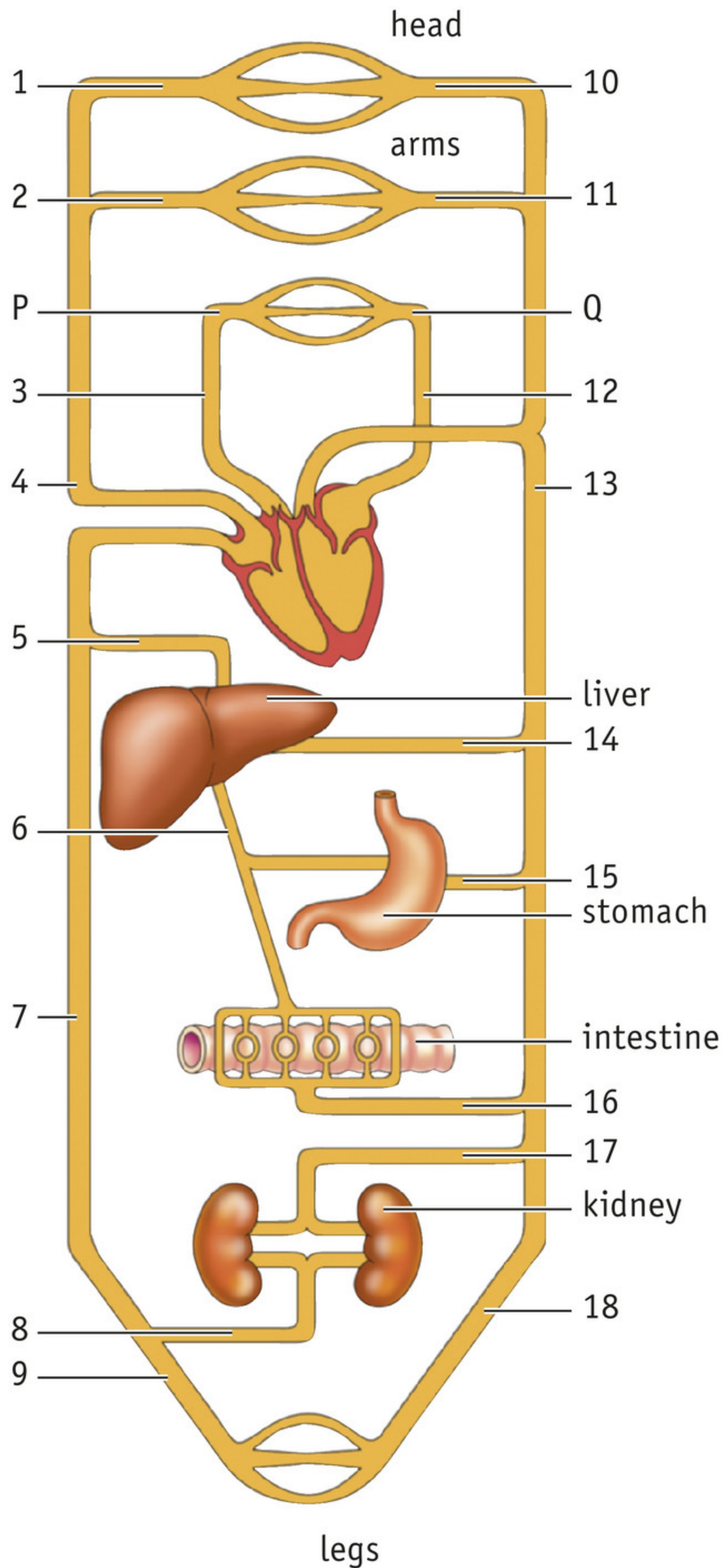
**OBJECTIVE 6**

Answer the following multiple choice questions.

Figure 80 shows a schematic drawing of the human circulatory system. Questions 1 and 2 are about this figure.

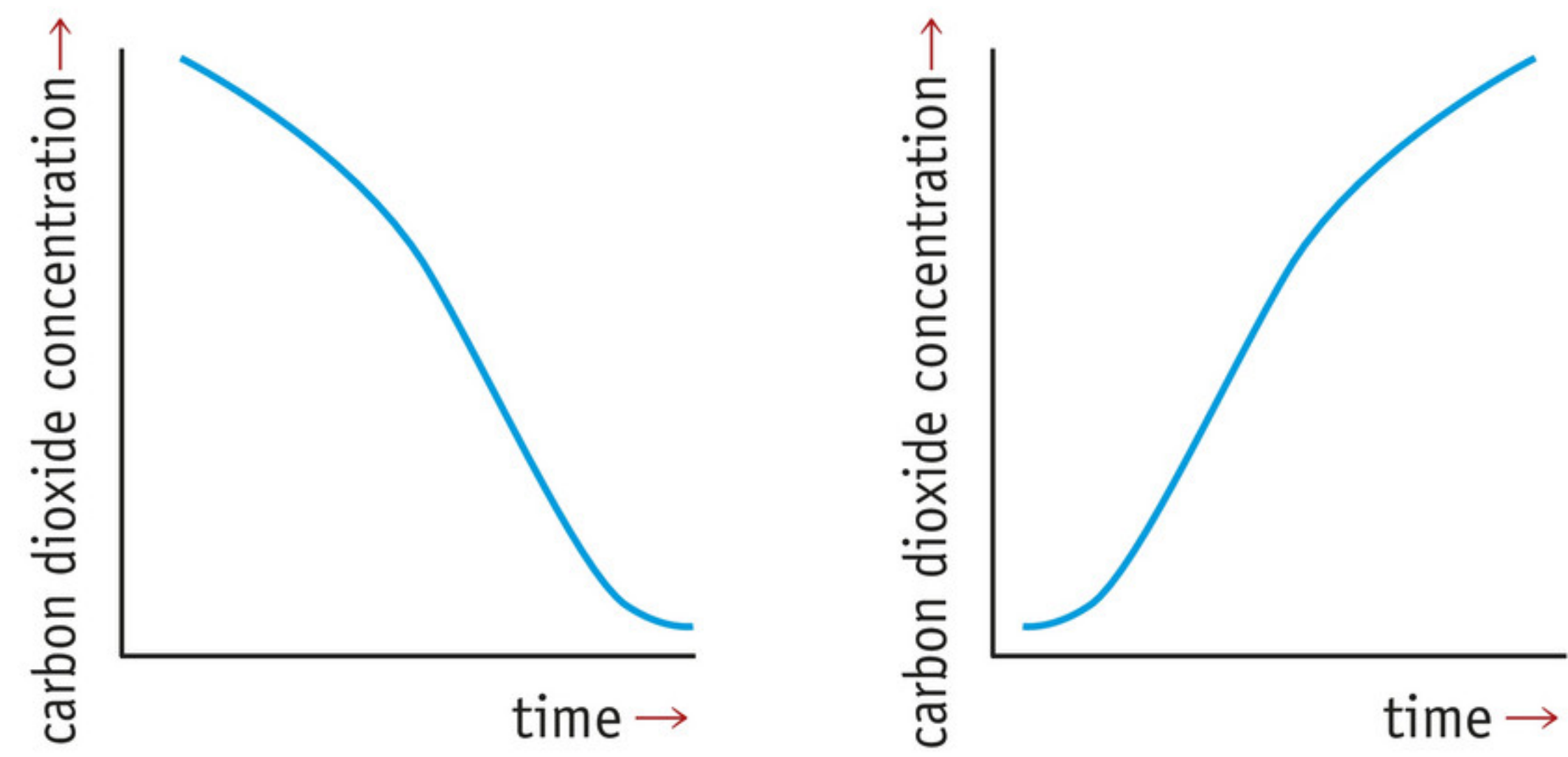
- 1 Which of the blood vessels labelled 1, 2, 3 and 4 is part of the pulmonary circulation?
- A Only blood vessel 3.
 - B Only blood vessels 1, 3 and 4.
 - C All the blood vessels: 1, 2, 3 and 4.

▼ Fig. 80 Circulatory system (schematic).



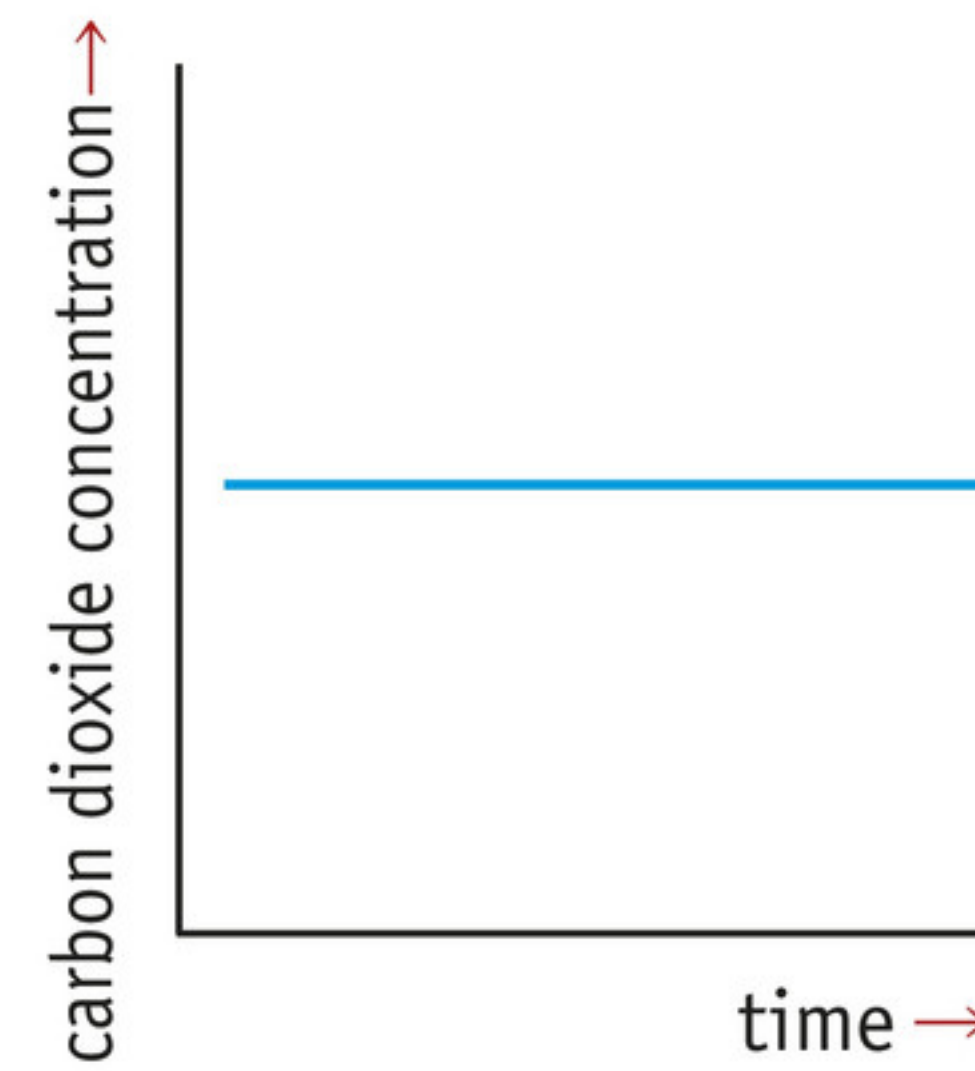
- 2 Figure 80 has blood vessels labelled P and Q. A study investigates what happens to the carbon dioxide level of the blood between these two vessels.
- Figure 81 shows three graphs.
- Which of these graphs shows schematically what happens to the carbon dioxide level of the blood between vessel P and Q in figure 80?
- A Graph 1.
 - B Graph 2.
 - C Graph 3.

▼ Fig. 81



graph 1

graph 2



graph 3

- 3 The blood in a woman's vein is low in oxygen and rich in carbon dioxide, and it contains few nutrients and a lot more waste products. Which of the following veins fits the description?
- A The portal vein.
 - B The superior vena cava.
 - C The pulmonary vein.
- 4 The blood leaving a certain part of the brain is low in oxygen. In which of the following blood vessels will that blood next be oxygenated again?
- A In a carotid artery.
 - B In a pulmonary vein.
 - C In a pulmonary artery.

OBJECTIVE 7

Answer the following questions.

- 1 If someone regularly feels a bit dizzy when they get up out of bed, do they have high or low blood pressure?
- 2 Does low or high blood pressure increase the risk of heart attacks?
- 3 Explain why someone who is overweight and does no sports is more likely to suffer from cardiovascular disease.
- 4 Has the woman in figure 82 suffered a stroke? Explain your answer.

- 5 Explain how the blood clot caused the temporary paralysis in the woman in figure 82.

▼ Fig. 82

A deadly dangerous love bite

A woman from New Zealand nearly died of a love bite. She was temporarily partially paralysed by a stroke. The 44-year-old woman was watching TV when she noticed that she was unable to move her left arm. The doctors noticed a love bite on the woman's neck. The suction had caused a blood clot in a vein under the woman's skin. That blood clot came loose and blocked a blood vessel in her brain. The woman has now recovered.



OBJECTIVE 8

Answer the following multiple choice questions.

- 1 Three groups of substances are:
- 1 waste products;
 - 2 harmful substances;
 - 3 nutrients.

Which of these substances is or are components of urine?

- A** Only 1.
B Only 1 and 2.
C 1, 2 and 3.

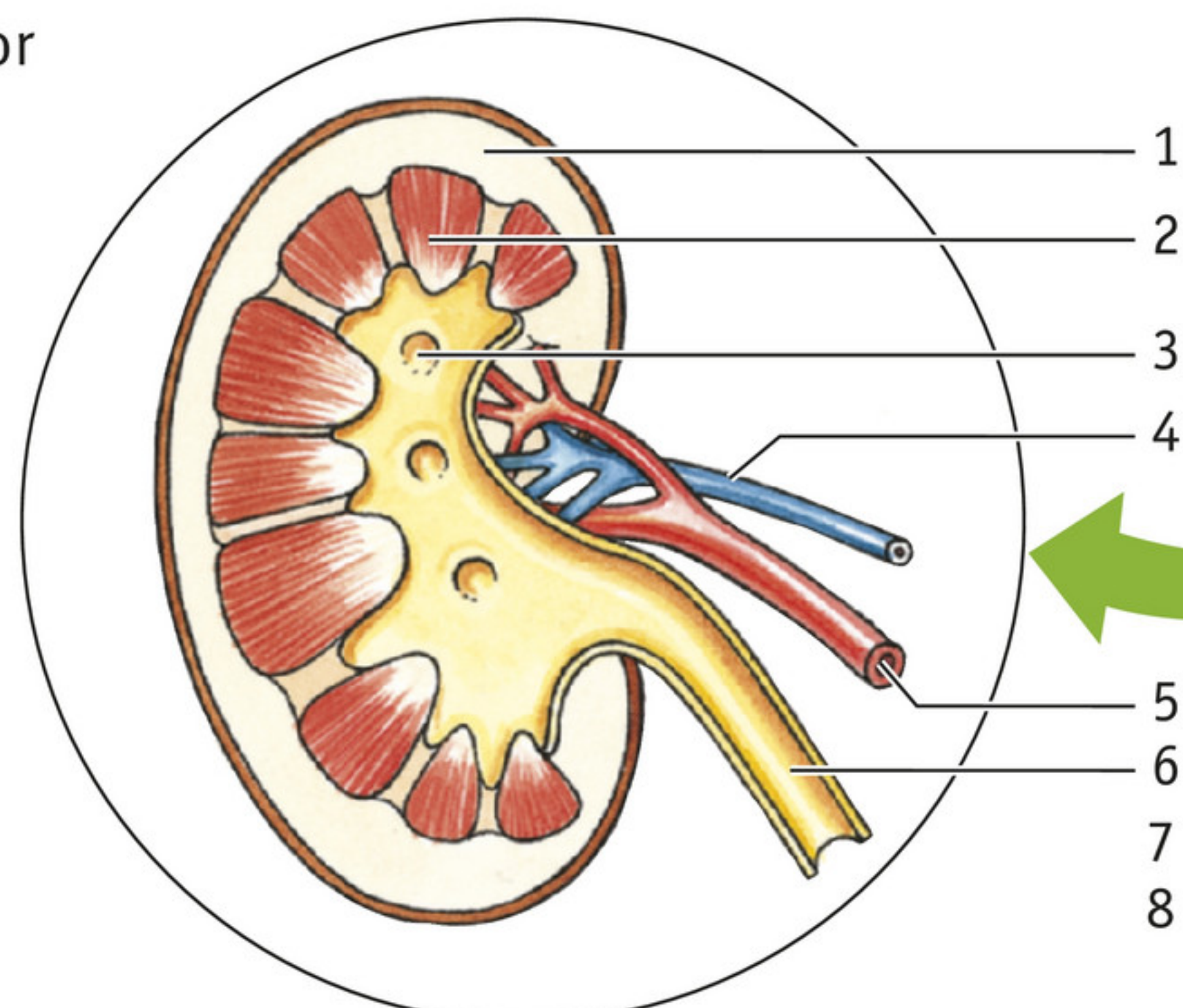
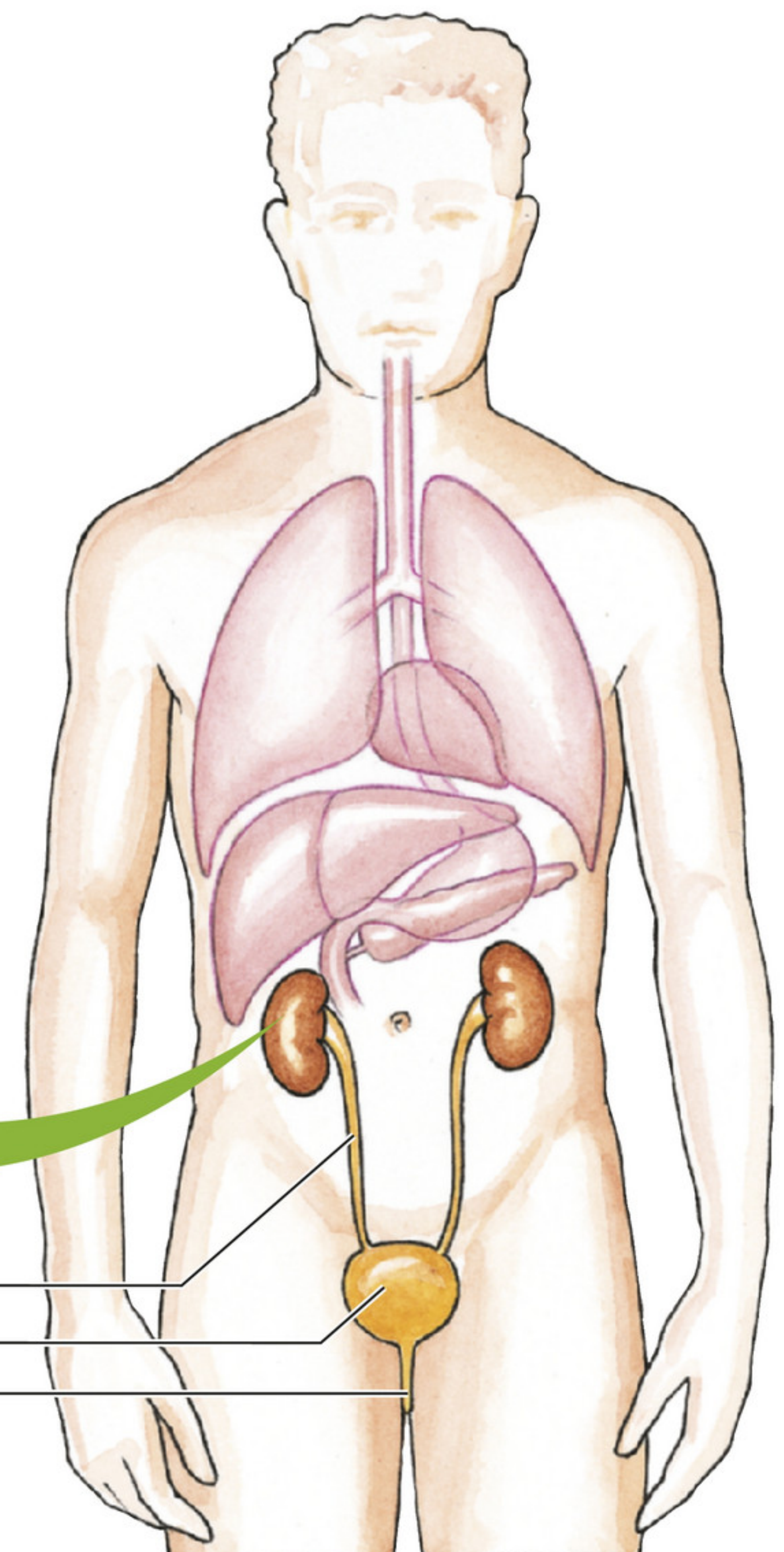


Figure 83 shows a drawing of the kidneys and urinary tract in a human. Questions 2 to 4 are about this figure.

- 2 Parts 4, 5, 6 and 8 are tubular organs that liquids flow through.
 Through which of these parts is urine transported?
A Only through part 8.
B Only through parts 6 and 8.
C Through parts 4, 5, 6 and 8.
- 3 What number is the label of a renal pelvis?
A Number 1.
B Number 2.
C Number 3.
- 4 In which of the following numbered parts is urine produced?
A In parts 1 and 2.
B In part 3.
C In part 7.

▼ Fig. 83



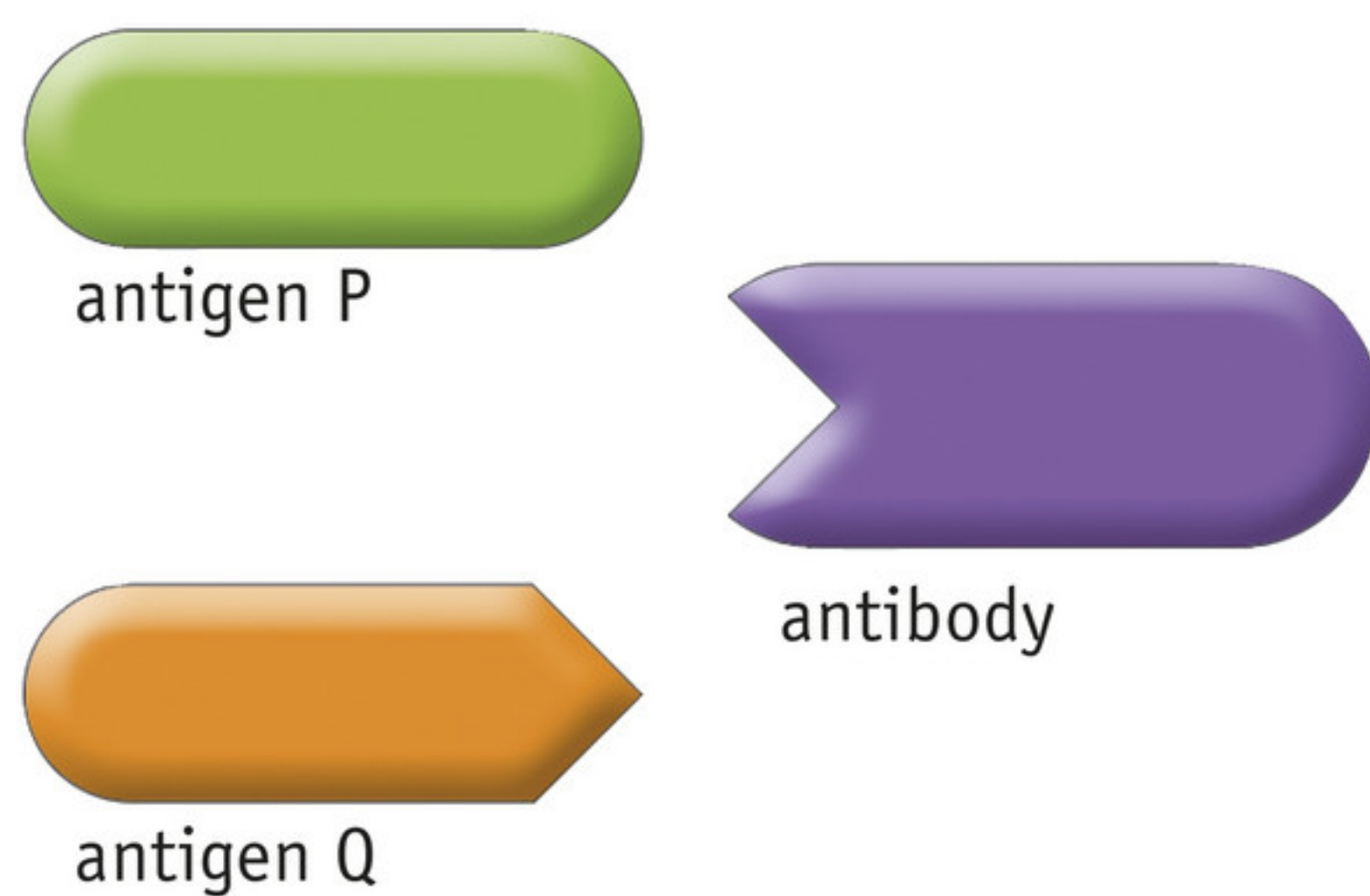
OBJECTIVE 9

Answer the following questions.

Figure 84 is a schematic drawing showing two antigens P and Q and an antibody.

- 1 Which antigen will the antibody attach to: P or Q?

▼ Fig. 84

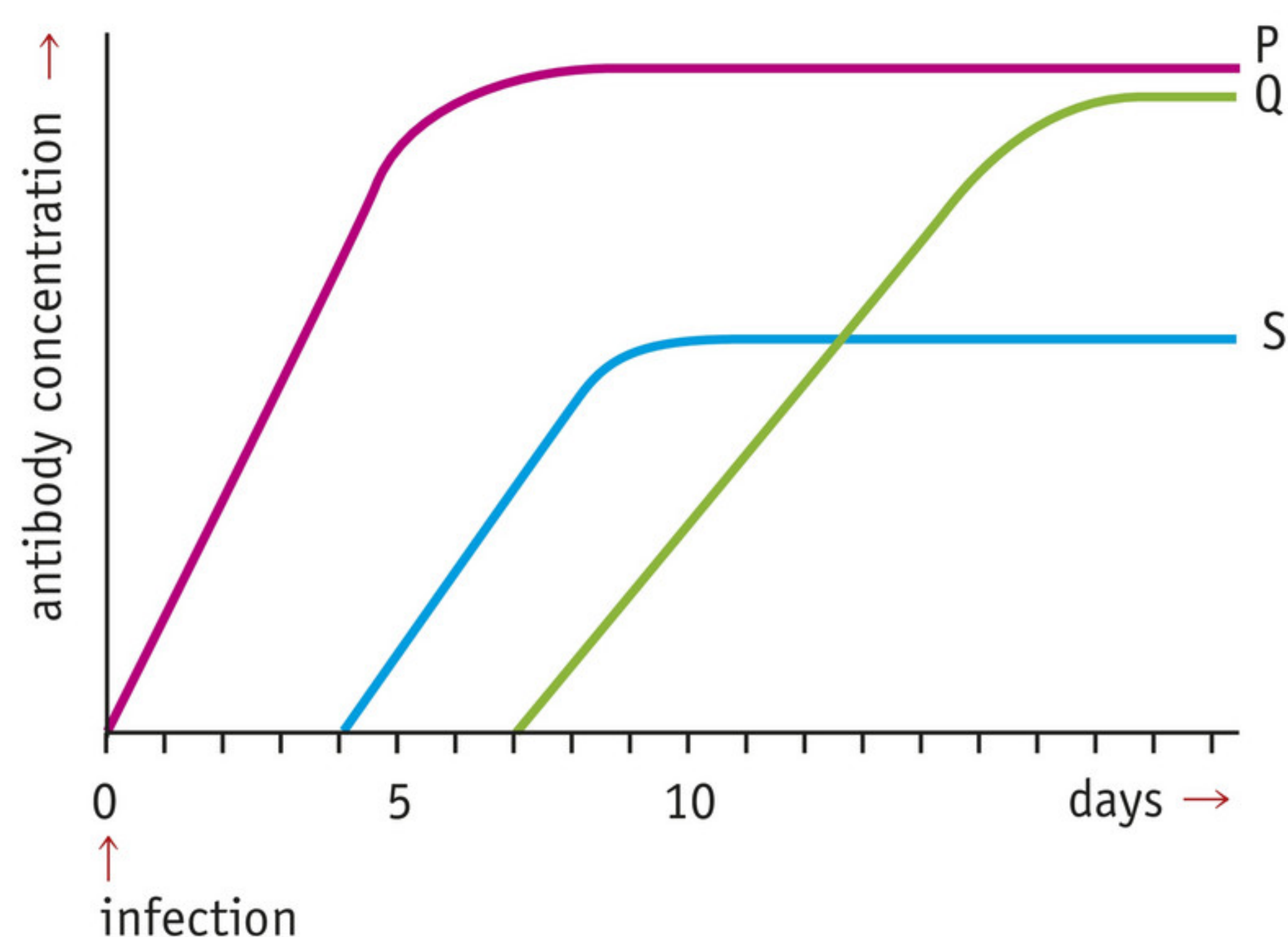


Yellow fever is a disease that is caused by a virus. After infection with the yellow fever virus, it takes about a week before the body starts making antibodies against the virus. Once the patients have recovered, they will be immune for the rest of their lives.

In the graph in figure 85, line Q shows the production of antibodies against the virus the first time a specific individual is infected. This person recovers and then gets infected again a year later.

- 2 Which line on the graph shows the production of antibodies after this second infection?
- 3 Danny has been vaccinated against yellow fever and against measles, mumps and rubella (MMR). Elizabeth has only had the MMR vaccination. Which of them is more likely to catch chickenpox? Explain your answer.

▼ Fig. 85



Bluetongue is a viral disease in sheep. There are 24 known variants, each with its own different antigens. In southern Europe, a vaccine is used that protects the animals against bluetongue types 2 and 4.

- 4 Does this involve injecting antigens or antibodies?
- 5 Do the sheep acquire natural immunity or artificial immunity?
- 6 How many different antigens must there be (at least) in the vaccine that is used in southern Europe? Explain your answer.

OBJECTIVE 10

Answer the following questions.

- 1 Alcohol has an effect on your organs, such as your brain, kidneys and liver. The consequences can be seen if you drink too much. Write the consequences of drinking alcohol next to the organs affected. Choose between: *aggression* – *alcohol is broken down* – *disinhibition* – *headache* – *poorer performance at school* – *slower reaction time* – *thirst*.
- 2 Note the short-term effects of alcohol in sequence from low blood alcohol level to high. Use: *drunk* – *relaxation* – *stupor* – *tipsy* – *unconscious*.
- 3 Luke drinks no alcohol during the week, but often drinks eight or ten glasses of beer on a Saturday evening. Susie drinks one or two glasses of wine in the evening, about five days a week. Which of the two will the alcohol be harming most, Luke or Susie?
- 4 Can regular binge drinking be dangerous in the short term? And in the longer term?

OBJECTIVE 11

Answer the following questions.

- 1 What is the active ingredient in cannabis?
- 2 Can cannabis make someone drowsy, yet still stop them from sleeping well?
- 3 Someone claims that smoking a cannabis cigarette (joint) is healthier than smoking tobacco, because it does not cause cancer (see figure 86). Is this correct? Explain your answer.
- 4 Explain why smoking cannabis can make someone feel dizzy and make them faint.

▼ Fig. 86

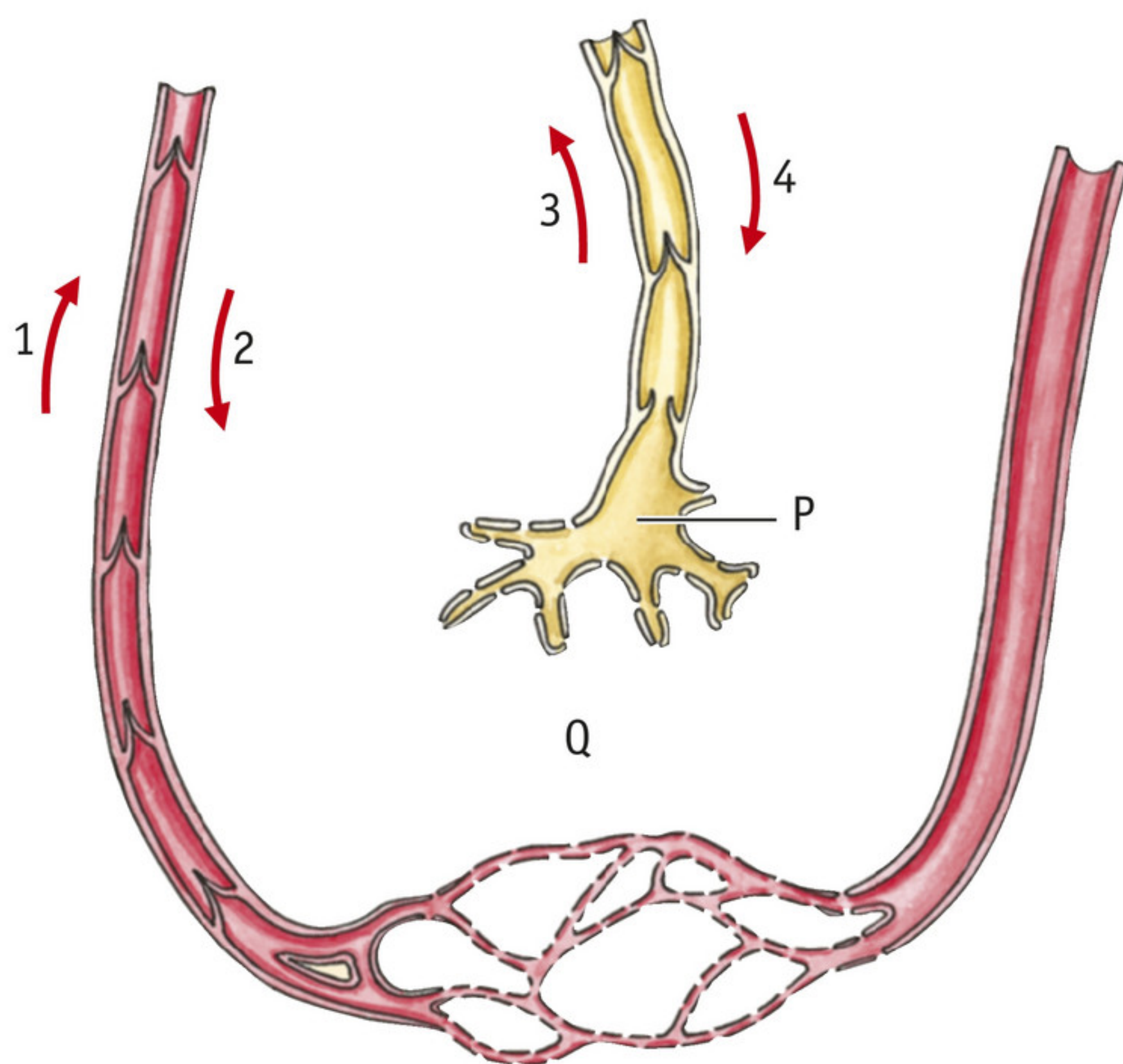
**EXTRA OBJECTIVE 12**

Answer the following multiple choice questions.

- 1 Substances that may be present in tissue fluid include glucose, carbon dioxide and oxygen. Which of these substances are transported to the cells by the tissue fluid?
 - A Only glucose and carbon dioxide.
 - B Only glucose and oxygen.
 - C Only carbon dioxide and oxygen.
 - D Glucose, carbon dioxide and oxygen.

Figure 87 is a schematic drawing of a number of blood vessels: a vein, capillaries, a lymph vessel and an artery. Questions 2 and 3 are about this figure.

▼ Fig. 87



- 2 Which arrow shows the direction of flow in a lymphatic vessel correctly?
 - A Arrow 1.
 - B Arrow 2.
 - C Arrow 3.
 - D Arrow 4.
- 3 Could there be white blood cells at position P in the drawing? And could there be oxygen at position P?
 - A Neither white blood cells nor oxygen.
 - B Only white blood cells.
 - C Only oxygen.
 - D Both white blood cells and oxygen.

EXTRA OBJECTIVE 13

Answer the following multiple choice questions.

- 1 For blood groups A, B, AB and O, we see both blood factors (antigens A and B) and antibodies (anti-A and anti-B). Which of these blood factors and antibodies are present in the blood of a person with blood group O?

<i>Blood factors</i>	<i>Antibodies</i>
A none	none
B none	anti-A and anti-B
C antigens A and B	none
D antigens A and B	anti-A and anti-B

- 2 Von Willebrand disease is a hereditary clotting disorder. Patients with a severe form of this disease can be treated by administering a specific medicine. Because this medicine is made from the blood plasma of healthy donors, it contains small quantities of the blood group antibodies anti-A and anti-B. Administering large quantities of this medicine can cause red blood cells of particular blood groups to start clumping together. Patients with one particular blood group can be treated with this medicine with no risk of the red blood cells clumping together. Which blood group is being referred to?

- A Blood group A.
- B Blood group B.
- C Blood group AB.
- D Blood group O.

- 3 Emma and Brad were travelling in Uganda. They were involved in a car accident and Emma was severely injured. Emma's blood group is B. The village hospital does not have any blood of group B available. Her boyfriend Thomas's blood group is A. He offers to give blood. The doctor says that Thomas is not a suitable donor.

Why?

- A Emma's blood contains antigen A.
- B Emma's blood contains antigen B.
- C Emma's blood contains anti-A.
- D Emma's blood contains anti-B.

- 4 Figure 88 describes a study into how blood groups can be changed.

Which proteins are removed in blood group A and which in blood group B?

In blood group A

- A antibody A
- B antibody B
- C antigen A
- D antigen B

In blood group B

- antibody B
- antibody A
- antigen B
- antigen A

▼ Fig. 88

Changing the blood group

Danish researchers have developed a method of changing the blood group of donated blood. Groups A, B and AB can be turned into group O by using enzymes to remove certain proteins (blood factors) from the outsides of the red blood cells. This invention could be a solution in some countries for the shortage of usable donor blood.



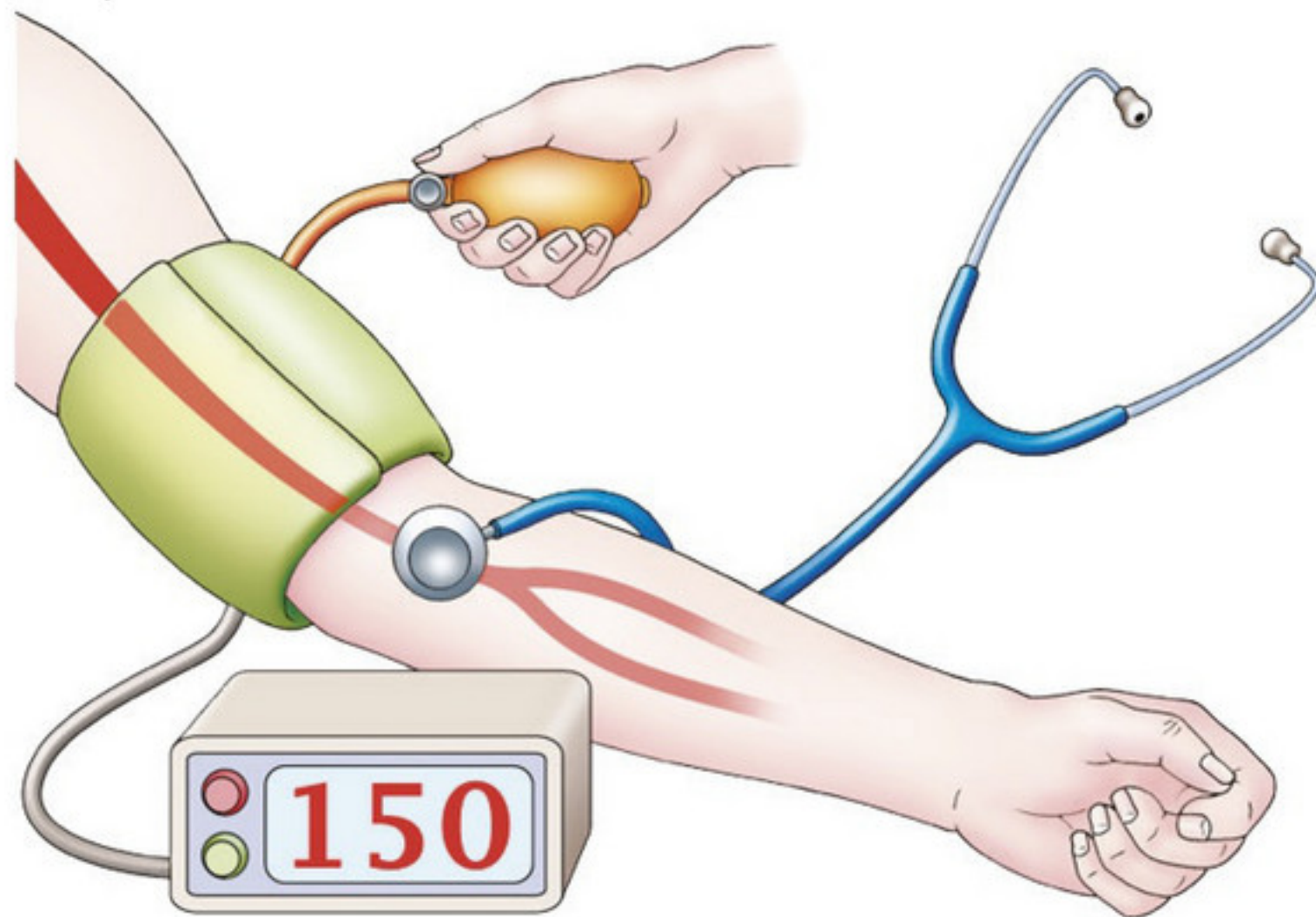
You can do the extension if you have time left over. You can choose between different topics. This unit's extension consists of three topics. You can do the exercises for them in your workbook. Your teacher will tell you how many topics you should choose.

1 Measuring blood pressure

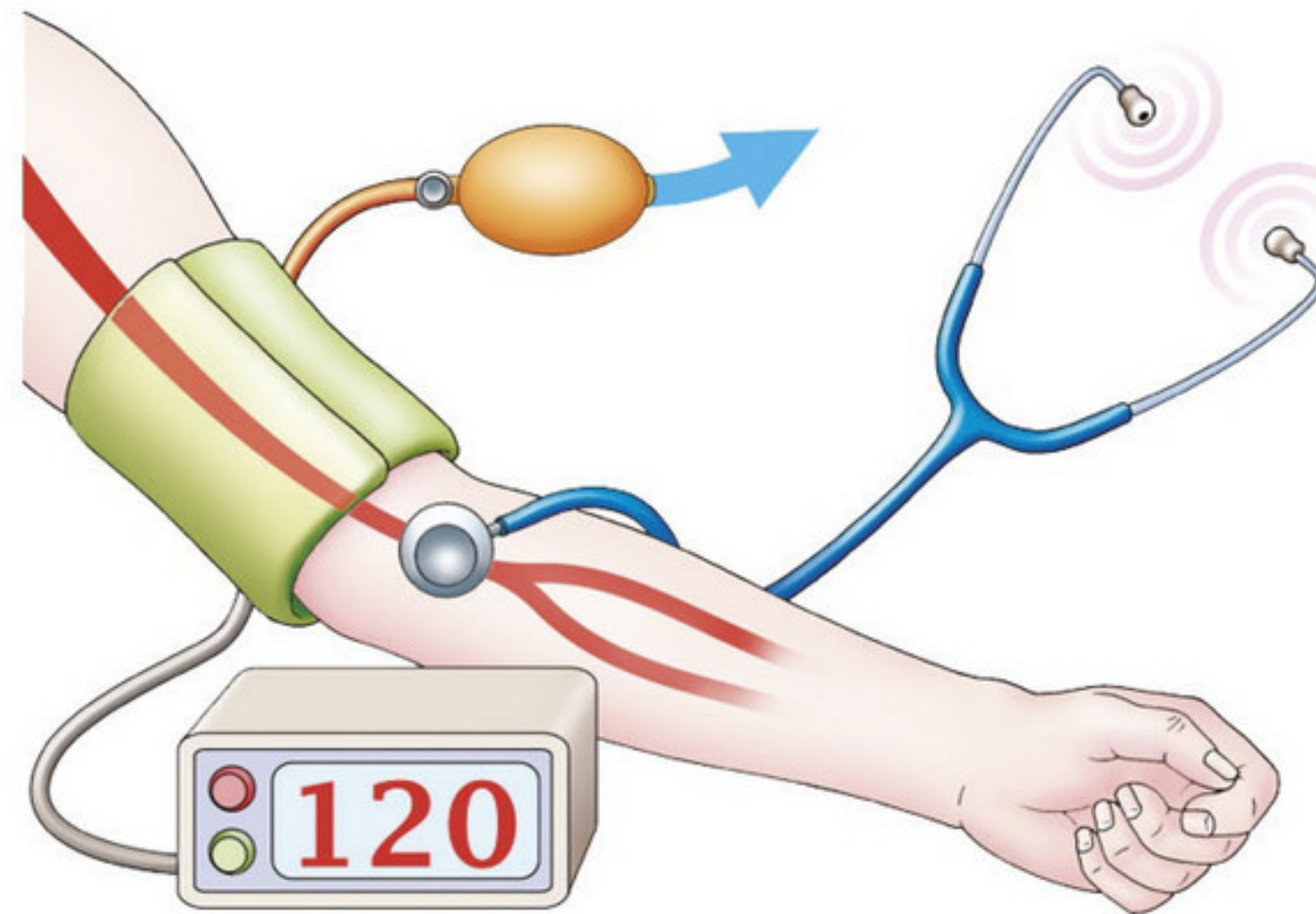
The blood pressure is highest during contractions of the ventricles. This is called the **systolic** pressure. The blood pressure is lowest during relaxation of the ventricles. This is called the **diastolic** pressure.

Figure 89 explains how the blood pressure is measured.

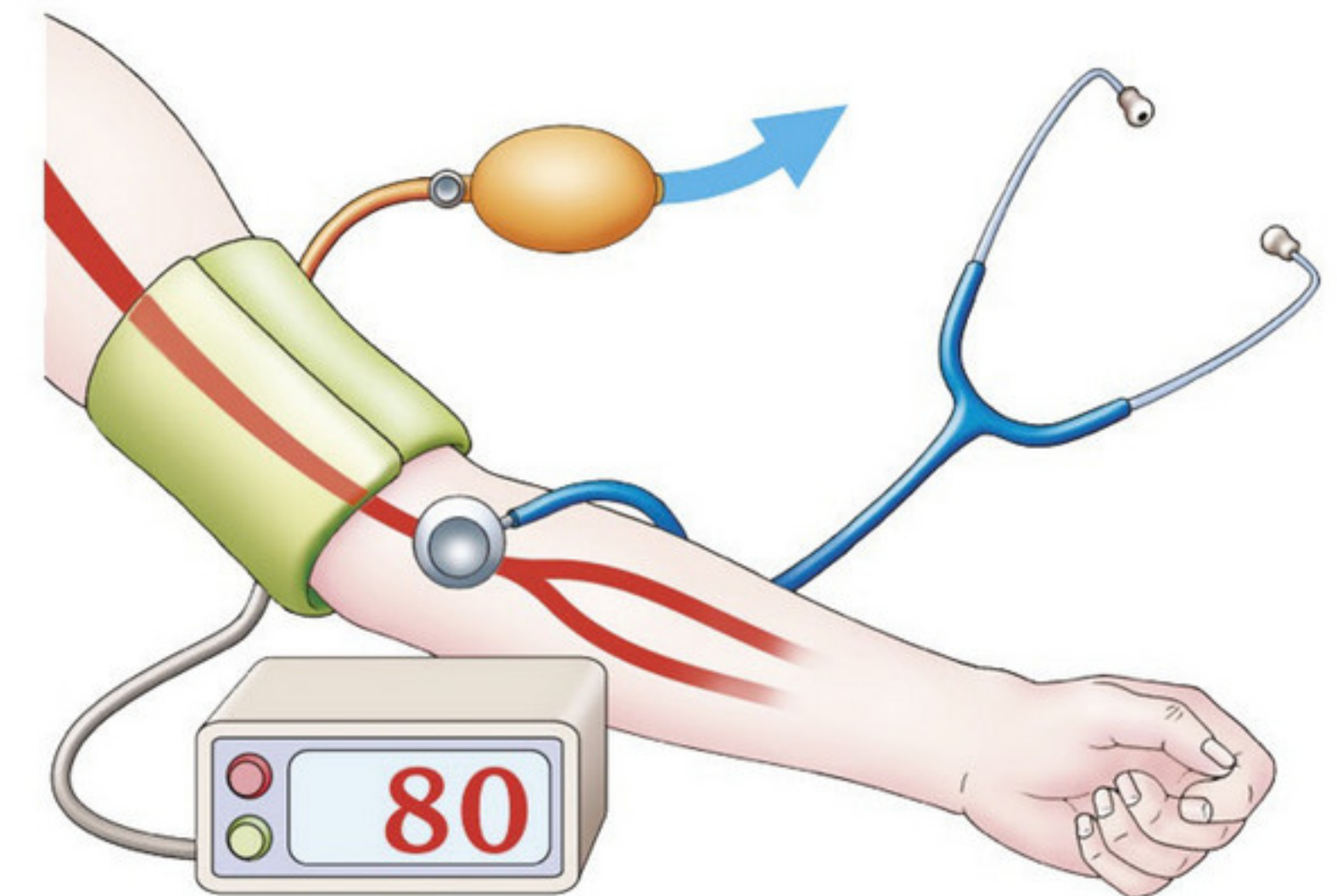
▼ **Fig. 89** Measuring the blood pressure.



- 1 the cuff is pumped up to a pressure that is greater than the highest blood pressure in the brachial artery

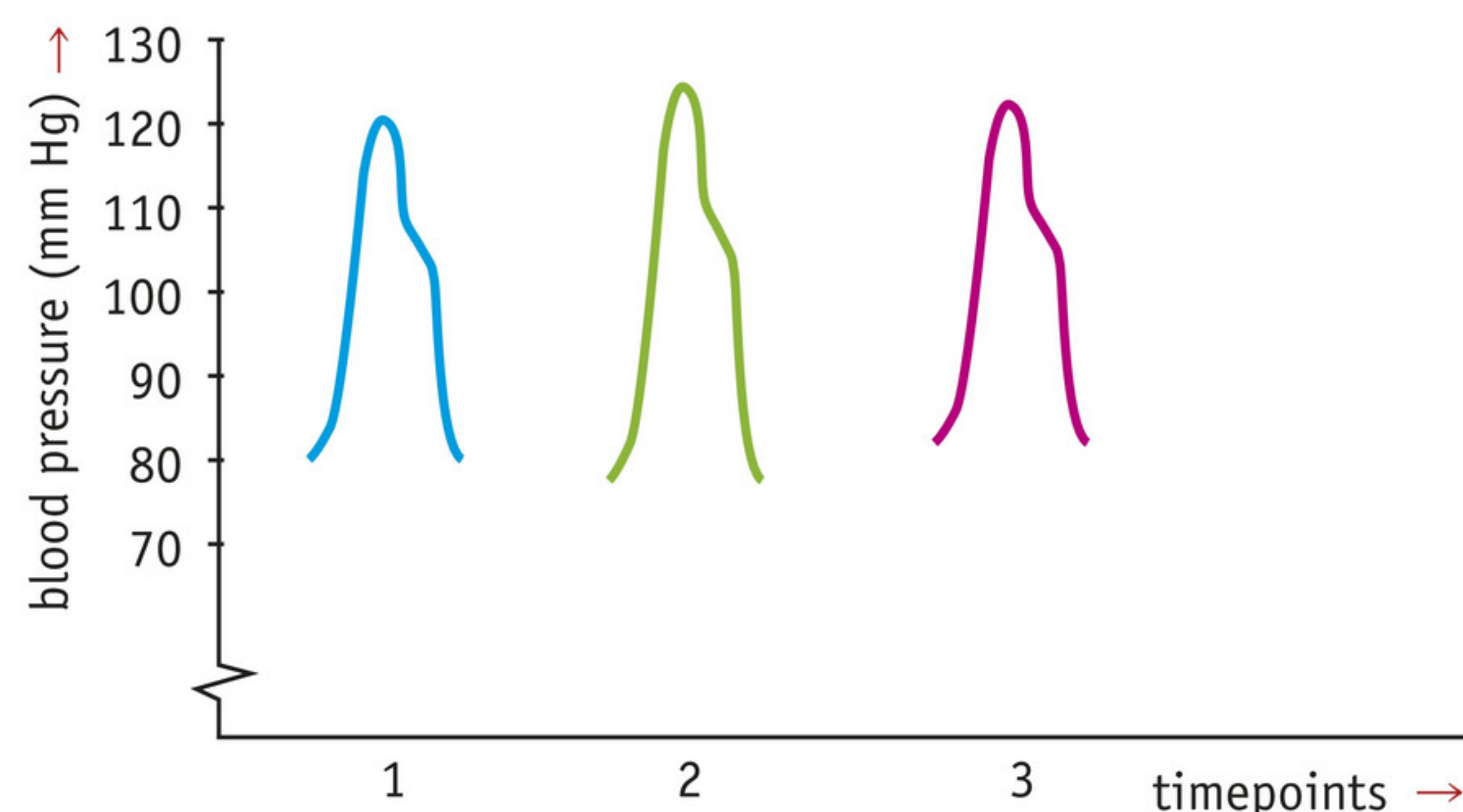


- 2 air is released from the cuff until a small amount of blood starts to get through the brachial artery with each heartbeat: the doctor reads off the systolic pressure



- 3 enough air has escaped to allow the blood to flow steadily through the brachial artery: the doctor reads off the diastolic pressure

► **Fig. 90** Blood pressure measurements at three timepoints.



▼ **Fig. 91** Digital wrist blood pressure meter.

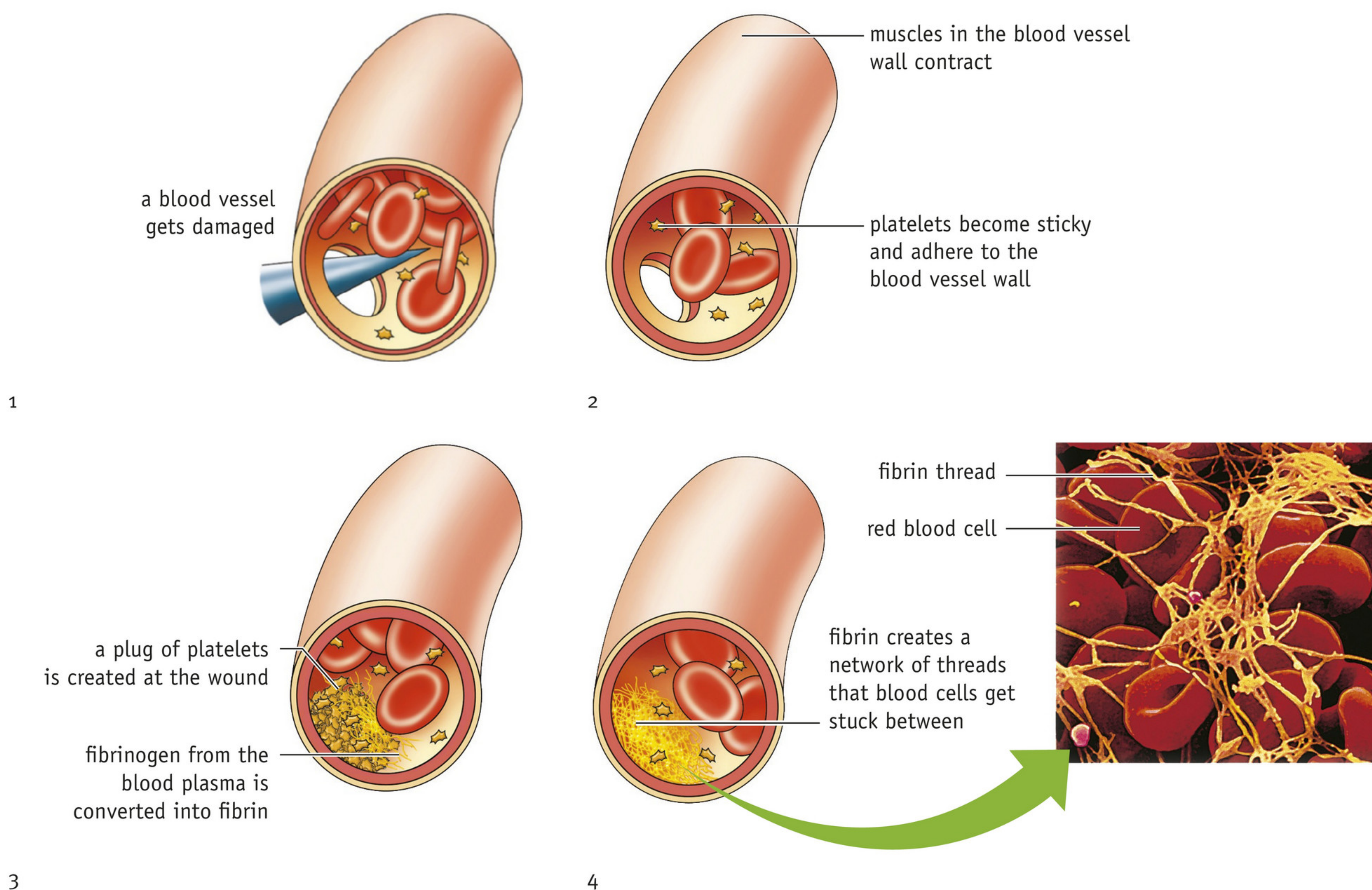


The units for blood pressure are millimetres of mercury (mmHg). Digital blood pressure meters let you check the blood pressure at home (see figure 91). The average systolic pressure is 120 mmHg and the average diastolic pressure is 80 mmHg.

2 Clotting

In basics 1, you learned that **platelets** and the plasma protein **fibrinogen** play a key role in clotting. Figure 92 shows clotting.

▼ **Fig. 92** Clotting.



▼ **Fig. 93** A scab forms over a wound.



During clotting, fibrinogen from the blood plasma is converted into **fibrin**. Fibrin creates a network of threads at the wound that blood cells get stuck between. When the fibrin threads and the blood cells dry out, a scab is formed (see figure 93). Once the wound underneath has healed, the scab falls away.

Haemophilia is a hereditary disease in which even a small wound can be dangerous because such a wound continues to bleed unless it gets medical treatment. It also often involves internal bleeding (bruises) and bleeding in the joints.

WB EXERCISES 1 AND 2, PAGE 132

3 Drugs

Drugs is a collective term used for both medicinal and recreational substances that have a narcotic, stimulant or psychoactive effect (see figure 94) and which can be addictive. Sometimes the distinction between the classes of effects is not so clear; XTC for example is a stimulant but it can also change how you perceive things.

▼ **Fig. 94** Various drugs.

narcotics



heroin and other opiates



sleeping pills and sedatives

stimulants



amphetamines (speed, pep pills)



cocaine



XTC



herbals and ephedrine



GHB

psychoactive substances



hash and grass



psychedelics (including magic mushrooms)

ADDICTION

When someone is on drugs, they keep needing more and more to achieve the same effect. This is known as **habituation** or **tolerance**. Someone is said to be **addicted** if they have become psychologically or physically dependent on the drug.

You are said to be **psychologically dependent** if you need the drug in order to feel well or to calm down. You are **physically dependent** if your body no longer functions properly without the drugs. If you stop using the drugs, you get **withdrawal symptoms**. You may then for example feel shivery, ill and feverish.

HARD DRUGS AND SOFT DRUGS

The Dutch **Opium Act** lists all the substances that the authorities regard as drugs.

The Opium Act distinguishes between hard drugs and soft drugs. **Hard drugs** are substances that are linked to unacceptably high risks. This includes for example heroin, cocaine, amphetamine, magic mushrooms and XTC (see figure 95). **Soft drugs** are substances for which the risks are less great. Examples include cannabis, sleeping pills and sedatives. The Opium Act does not define tobacco and alcohol as drugs. These substances are socially more or less accepted, although in terms of harm and risks, they are comparable to hard drugs.

WB EXERCISES 1 AND 2, PAGE 134

▼ Fig. 95

XTC fatality at a mega dance party

VENLO – A 15-year-old schoolgirl died last weekend from an XTC overdose at a mega dance party. XTC is popular among party-goers but can potentially be fatal. After the girl had taken a pill, she noticed very little effect after a while and so she took a few more pills. She was taken to hospital in a coma and with a temperature of 43 degrees, where she died five hours later. The XTC pills were also contaminated with toxic substances. There were also glass splinters in the pills that were supposed to roughen up the stomach wall so that the pills would take effect more quickly.



4

Reproduction



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This unit is called 'Reproduction'. Everyone dies sooner or later. Because people reproduce, there are always new people to replace them. After about your tenth birthday, lots of changes start taking place in your body. Your sex organs start to work. A boy will start producing semen and a girl will have her first period. In this unit, you will learn about the reproductive organs and how they work. A man and a woman can have sexual intercourse with each other. A woman can become pregnant as a result. You will learn about pregnancy and how you can prevent pregnancies and sexually transmitted infections (STIs).

When you read the basics, you will come across the exercises as you go. You should do the exercises in your workbook.

1 You are changing...

People are all different from each other. Men look different to women, boys are different from girls. Young men also look different to older men. And you can also see differences between boys of the same age.

You can tell whether a baby is a boy or a girl the moment it is born.

The features of people that let us tell the gender are called the **sexual characteristics**. The sexual characteristics that are already present at birth are known as the **primary sexual characteristics**. Figure 1 shows you the primary sexual characteristics of a boy and a girl. Boys are distinguished by the penis and scrotum. A girl has a vagina and labia.

► **Fig. 1** Primary sexual characteristics are present from birth.



From any time after your tenth birthday, changes will start happening. **Puberty** starts from about age twelve. During puberty, you will experience physical, emotional and social changes.

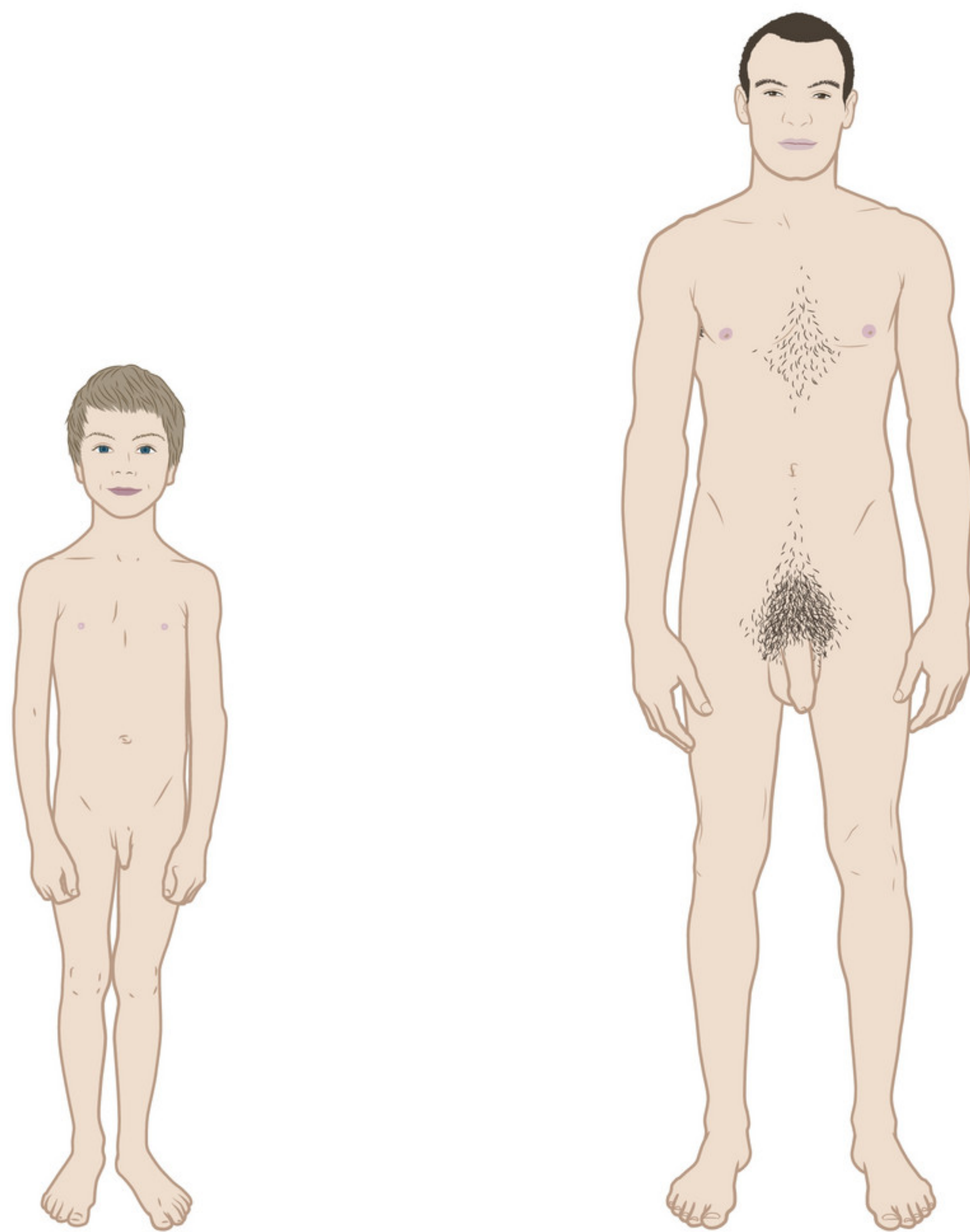
PHYSICAL CHANGES

You will be able to see some of the **physical changes** taking place in your body. For example, from about age 12 you will start to grow quickly (the **growth spurt**). It may make you start feeling gangly and awkward. You will start growing hair under your arms and around the sex organs. There are other physical changes that you will not be able to see. For instance, the reproductive organs inside your body will start to function.

The sexual characteristics that start appearing from about age ten onwards are called the **secondary sexual characteristics**. You can see these characteristics if you compare an adult with a child. In figure 2, you can see that an adult man is more muscular than a boy. The man has a beard and chest hair. The man's voice will also have become deeper during puberty (the voice 'breaking').

Figure 3.2 shows you secondary sexual characteristics of a woman. You can see that a woman has a more rounded body shape than a girl. During puberty, the woman's breasts have grown and the hips have become broader.

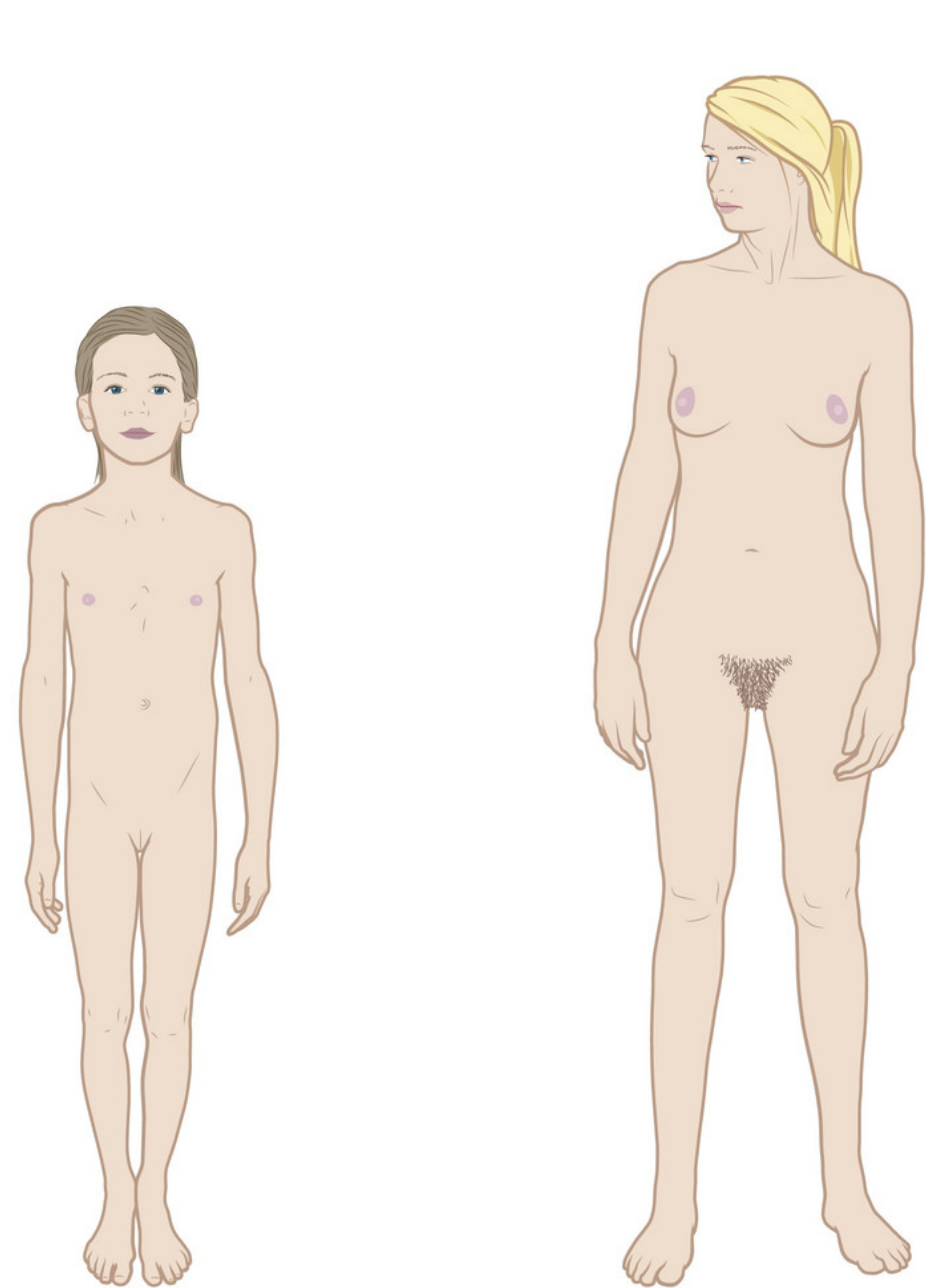
▼ **Fig. 2** Sexual characteristics in boys and men.



1 primary sexual characteristics in a boy

2 secondary sexual characteristics in a man

▼ **Fig. 3** Sexual characteristics in girls and women.

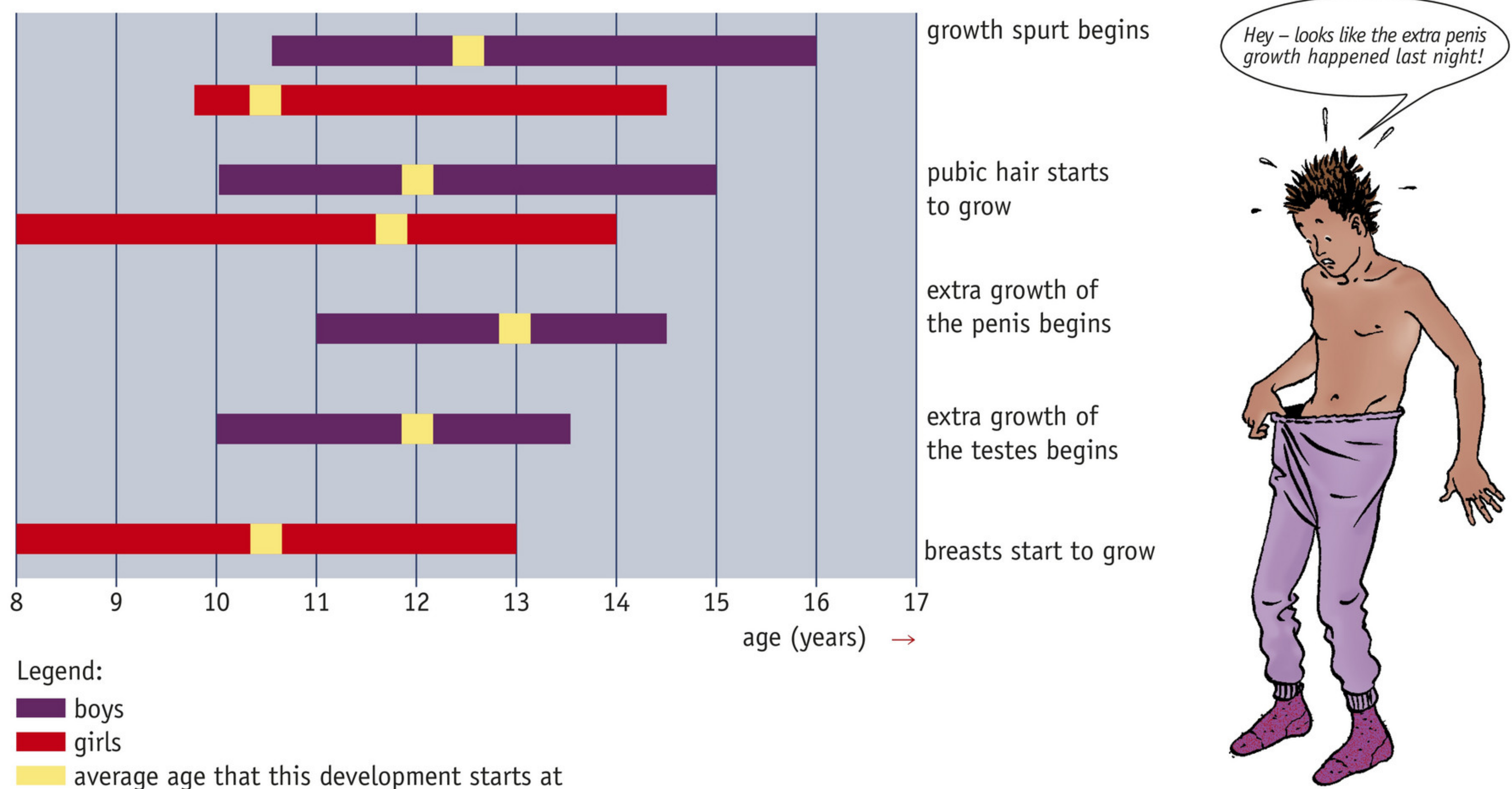


1 primary sexual characteristics in a girl

2 secondary sexual characteristics in a woman

The physical changes during puberty do not all happen at once. Some changes appear early in puberty, others much later on. In some people, certain changes may not take place at all, or only a little bit. Lots of men do not get chest hair, for example, and some hardly get any beard hair. Figure 4 lists some of the changes and the ages the developments can start in boys and in girls. As you can see, there is quite a range of ages. Each boy and each girl will develop at their own pace. There is therefore no need to worry if you are a bit later or earlier than the average.

▼ **Fig. 4** Diagram of the development of boys and girls.



Girls are often worried about the way their breasts are developing, for example because one breast is growing quicker than the other. It will even out in time. Or they may be worried because they think their breasts are too large or too small. There are no such thing as ideal breasts or a perfect body, even though some advertisers might want to make you think otherwise (see figure 5).

During puberty, a girl's nipples become larger and darker coloured. The nipples may stand out if they are stroked, or simply because of the cold.

▼ Fig. 5

Is there such a thing as the ideal body?

Many young people see so-called ‘ideal’ bodies in all kinds of advertisements and then feel that their body ought to look like that too. But those pictures are not very realistic. They have been taken by professionals and the photos have often been retouched on the computer (see the photos).

Studies by Professor Liesbeth Woertman have shown that young people who see a lot of images on television, the Internet and in magazines tend to be less satisfied with their own bodies. Normal bodies look very different from that, and very different to each other. Nothing like the models in the media. Have a good look round at the swimming pool.

Liesbeth Woertman says, “Girls are generally a bit more susceptible to the ideal of beauty than boys are. If a girl or woman wants to conform to the prevailing ideal of beauty, she could hardly eat anything, would have to get extreme amounts of exercise and go regularly

to the plastic surgeon to get various bits tweaked and tucked.” So you’re better off if you stop comparing yourself to images that do not have anything to do with reality.



real

manipulated

EMOTIONAL CHANGES

Your **emotional** view of the world changes during puberty too. You are heading for adulthood, slowly but surely. Your feelings change and you become more independent. This progresses more quickly for some people than for others. On average, girls mature more quickly than boys.

In puberty, you get more interested in other people. **Sexuality** begins to play an increasingly important role in your life. You sometimes feel strongly attracted to one special person and may then fall **in love** with them. You then try to catch that person’s attention and be particularly nice to them. If that other person falls in love with you as well, you will feel very happy. You may start a steady **relationship** with that person.

That you love each other may be demonstrated by stroking, kissing and cuddling. Ultimately, it may lead to you having **sexual intercourse**.

▼ Fig. 6 In love!



SOCIAL CHANGES

Your **social** view of the world changes during puberty too. You will start acting differently towards your parents. You do not want to be treated like a little kid any more. You may sometimes fly into a rage. You may act differently with your friends too. Whereas you perhaps preferred to have one best friend before, you may now feel much more at ease in a group of young people.

You may experience puberty as an enjoyable and exciting time, or you may also often feel very unsure or lonely or sad. These feelings are part of puberty. As you get older, they will affect you less often.

WB EXERCISES 1 TO 4, PAGE 136

► Fig. 7



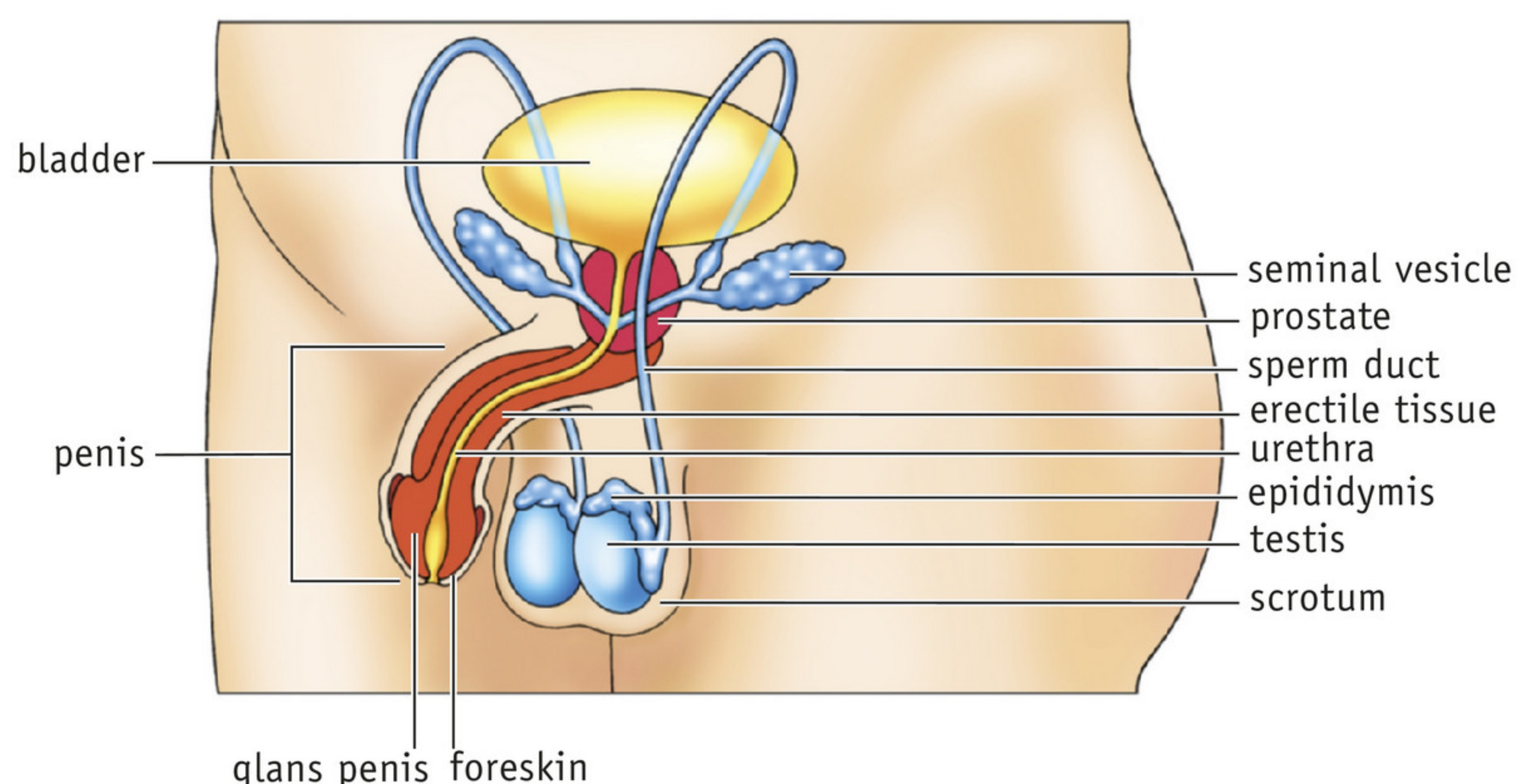
2 The male reproductive system

▼ Fig. 8



Figure 8 is a photo of a naked man. You can only see part of his reproductive system. The rest of the reproductive organs are located in the lower abdomen. Figure 9 shows the male reproductive system schematically.

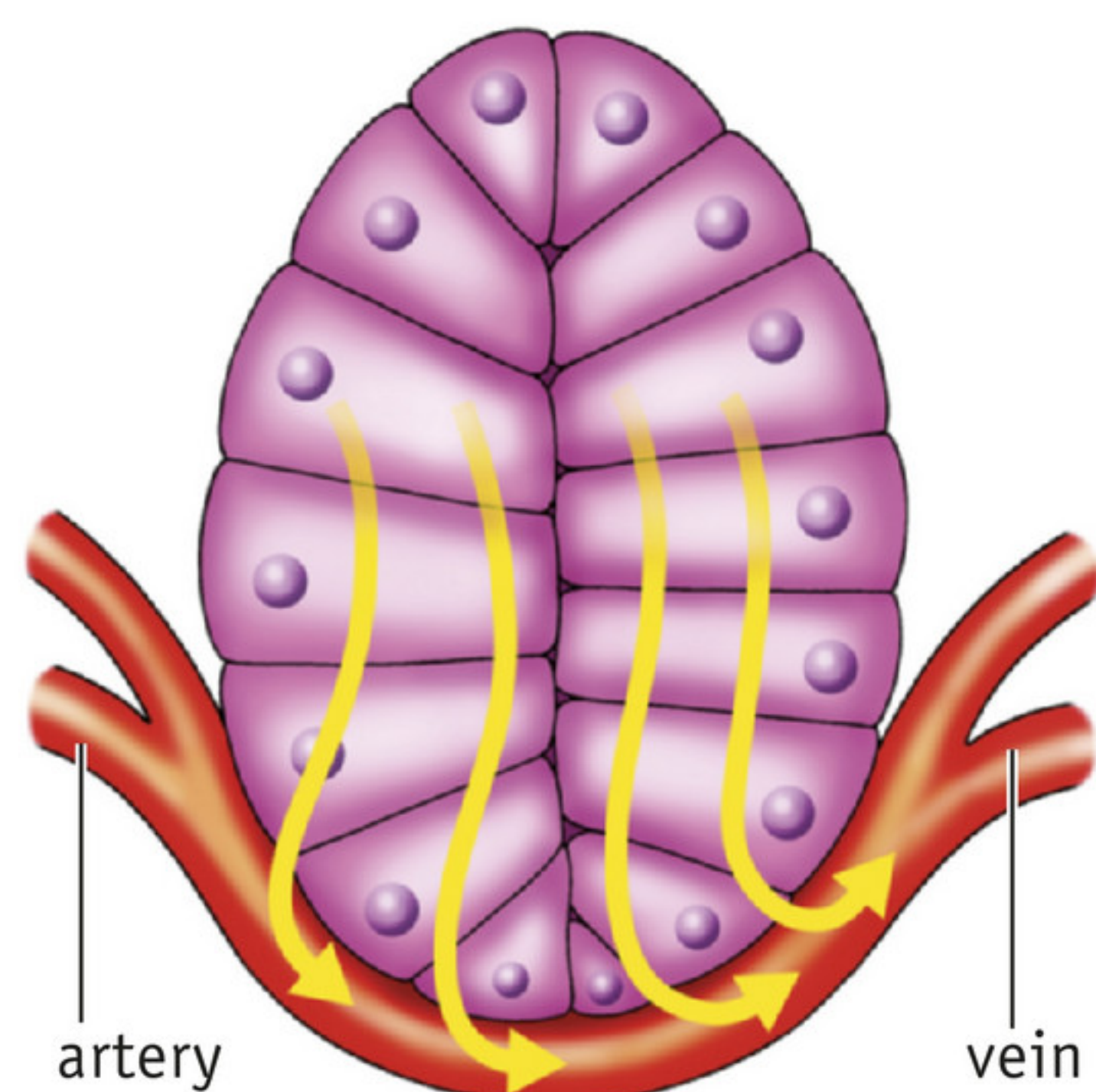
▼ Fig. 9 The male reproductive system (diagram).



When a boy is aged about thirteen, his **testes** start to function. From that age onwards, the testes produce many millions of **sperm cells** every day. Sperm cells are the male sex cells. The testes are located in a fold of skin called the **scrotum**. The temperature in the scrotum is slightly lower than in the abdominal cavity, which is favourable for the development of sperm cells.

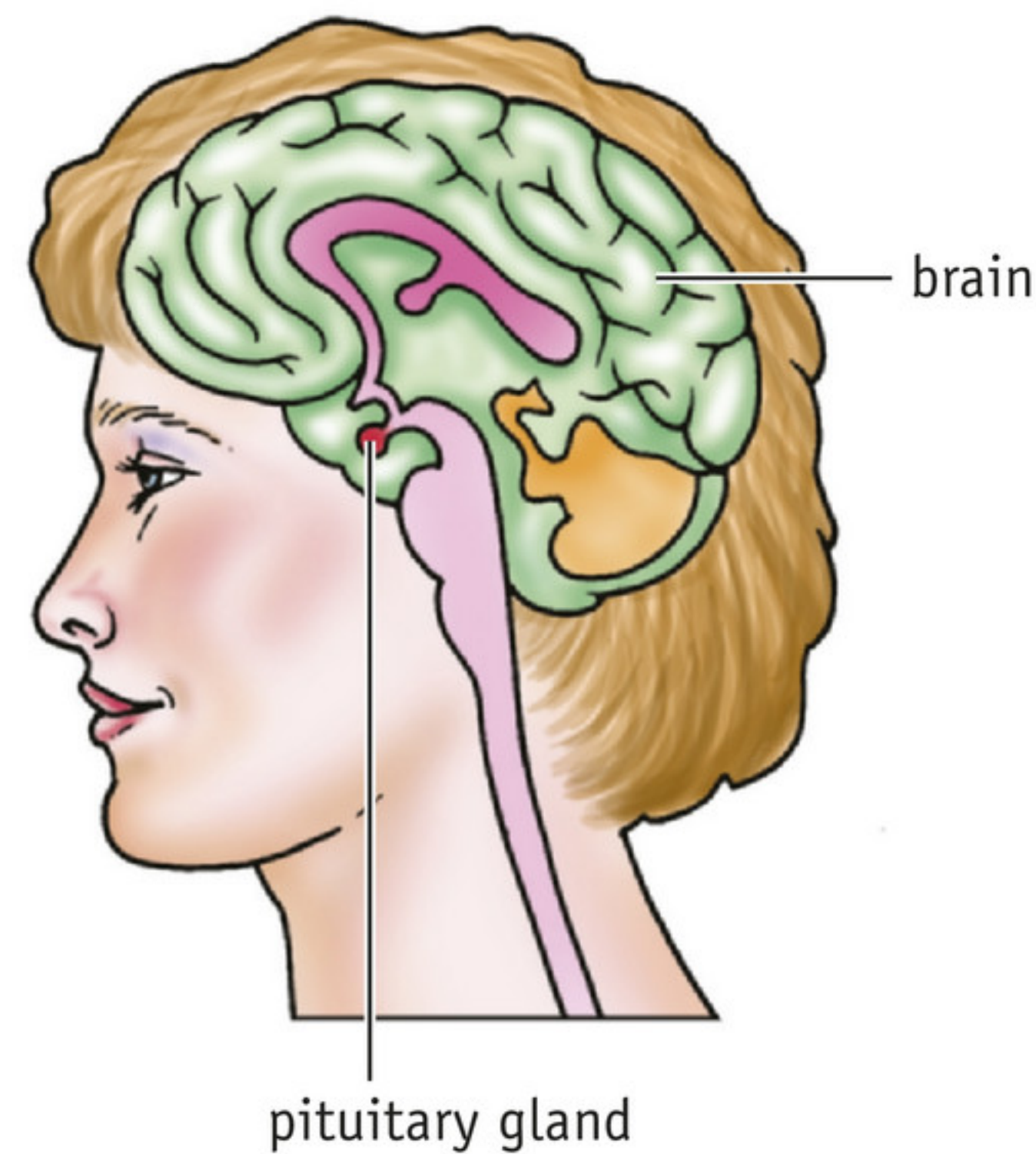
Hormones play an important role in the formation of sex cells. Hormones are substances that control all kinds of processes in your body. Hormones are produced by the **endocrine glands** (see figure 10). Endocrine glands secrete their hormones into the bloodstream. The hormones then flow with the blood throughout the body. However, they only have an effect in the organs that are sensitive to them.

▼ Fig. 10 An endocrine gland secretes hormones into the blood, which then transports the hormones to all parts of the body.



The **pituitary gland** is an important endocrine gland. It is located at the underside of the brain (see figure 11). In puberty, the pituitary gland starts to produce certain stimulatory hormones. Under the influence of those hormones, a boy or man produces sperm cells in the testes. In a man, the pituitary gland keeps producing these stimulatory hormones through to an advanced age. Sperm cells can therefore also be produced until an advanced age.

► **Fig. 11** Location of the pituitary gland.



The sperm cells are stored temporarily in the **epididymis**. The **sperm ducts** transport the sperm cells.

The **seminal vesicles** and the **prostate** add fluid to the sperm cells. The fluid from the seminal vesicles contains nutrients for the sperm cells. The fluid from the seminal vesicles and the prostate gland plus the sperm cells together is all referred to as **semen**.

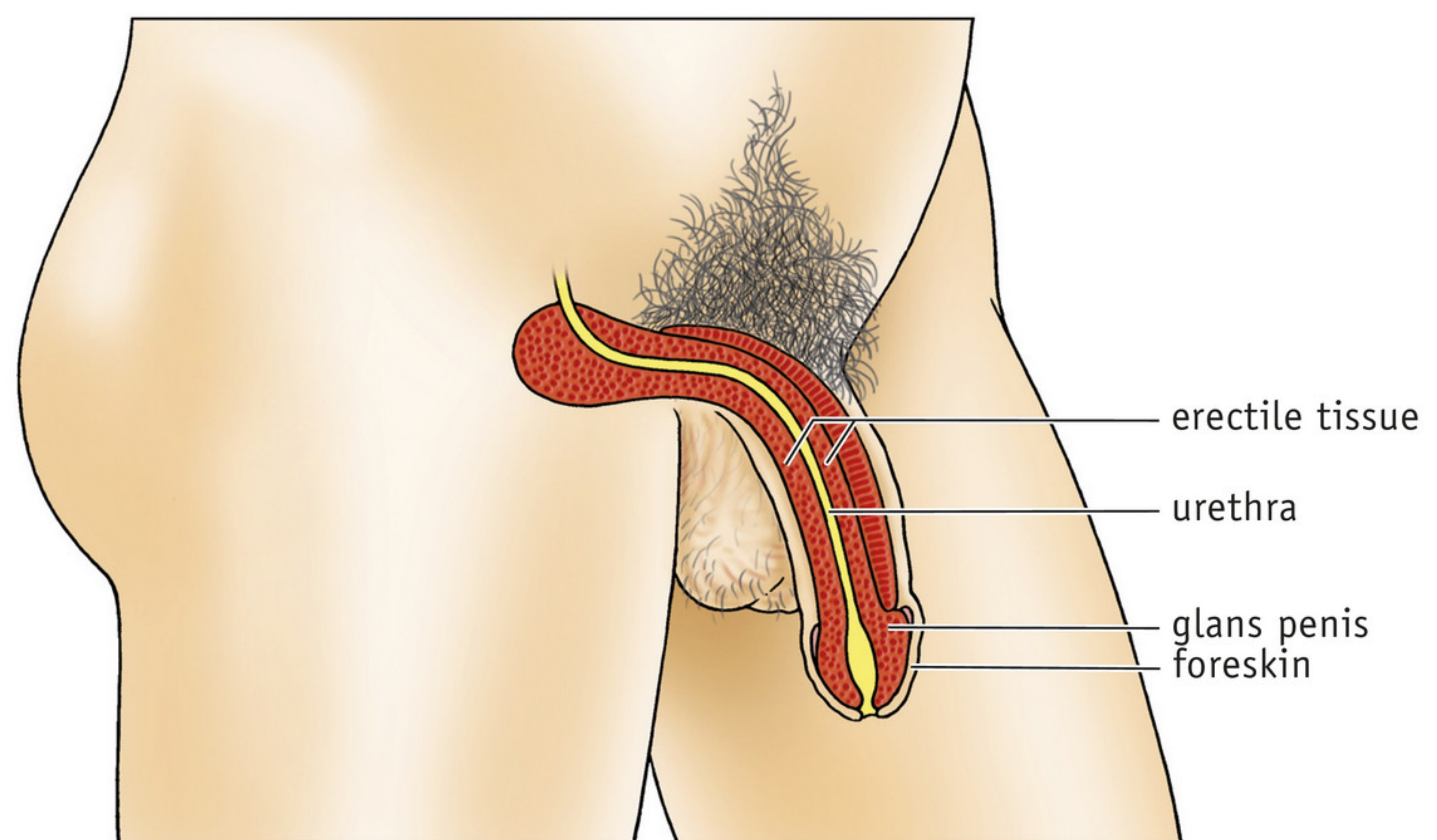
At the prostate gland, the sperm ducts exit into the **urethra**. In an **ejaculation**, the semen comes out via the urethra. The urethra also transports urine from the bladder.

The urethra goes through the **penis**. The end of the penis (the head or **glans penis**) is very sensitive. Touching the glans or head of the penis is often a stimulus that arouses a man sexually. The head of the penis is covered by a thin fold of skin called the **foreskin**. The foreskin is large enough that it can be retracted back over the head of the penis. To avoid infections, it is important that a boy or man pulls the foreskin back when showering so that the glans penis and foreskin can be rinsed. Some peoples cut away the foreskin; this is called circumcision. This is often done for hygienic reasons. Sometimes it is also done for religious reasons, for example in the Jewish and Islamic faiths.

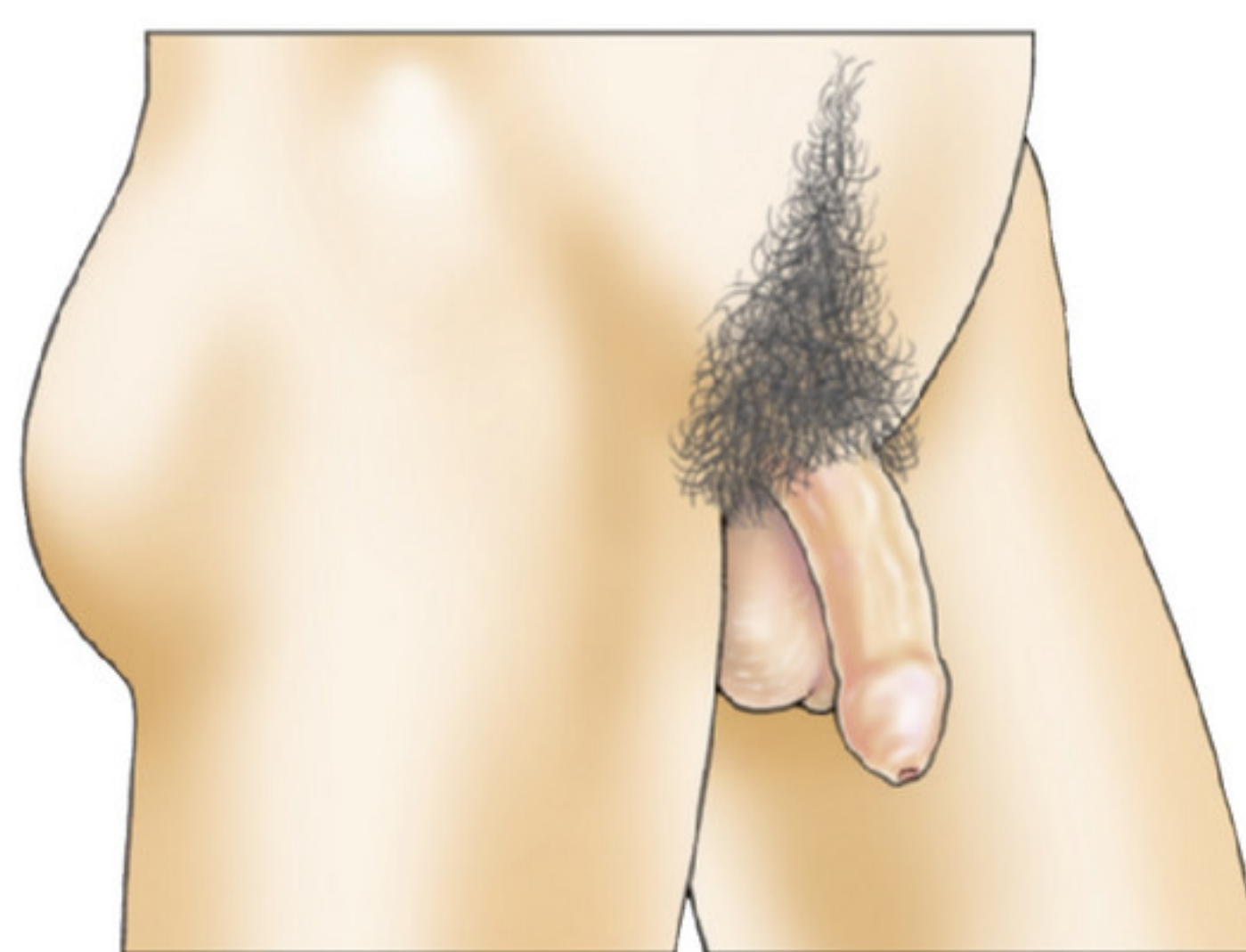
The purpose of the penis is for placing sperm cells inside the body of a woman. The penis mostly hangs loosely or 'flaccid', but it can also become larger and stiff. This is referred to as an **erection**, or other terms such as a 'hard-on'. An erection is caused by the **erectile tissue** in the penis (see figure 12). This tissue can become filled with blood, making it larger and firmer. The penis then becomes erect (see figure 13). The size and shape of the flaccid penis can vary quite a lot between men. But there is not so much difference between erect penises. And the size of the penis is not as important as being able to feel good sensations.

Boys and men can get erections at the most inconvenient moments. For example during examination by a doctor, a bit of rough-and-tumble, or when dancing close. Boys and men often get erections at night or when they wake up.

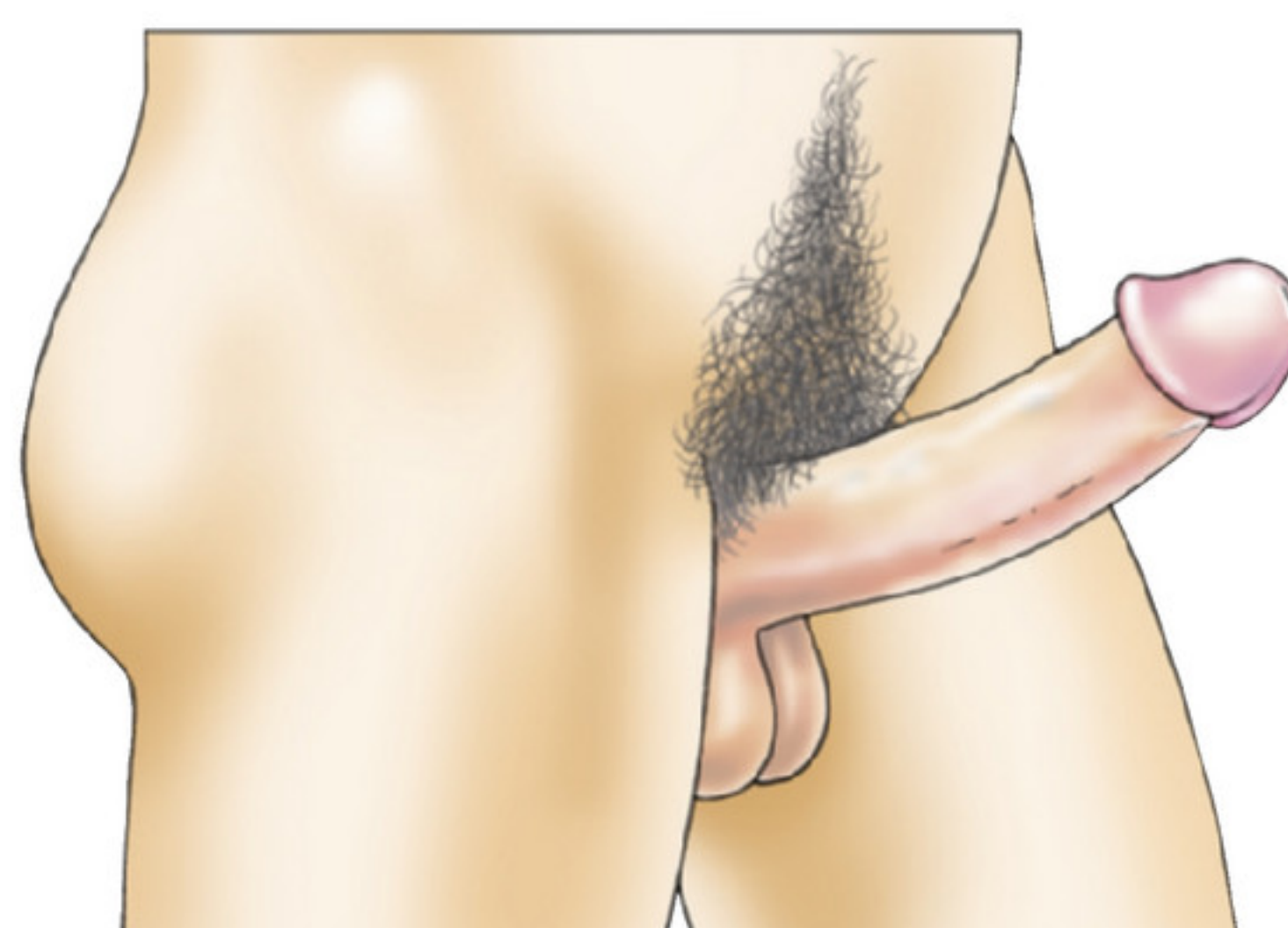
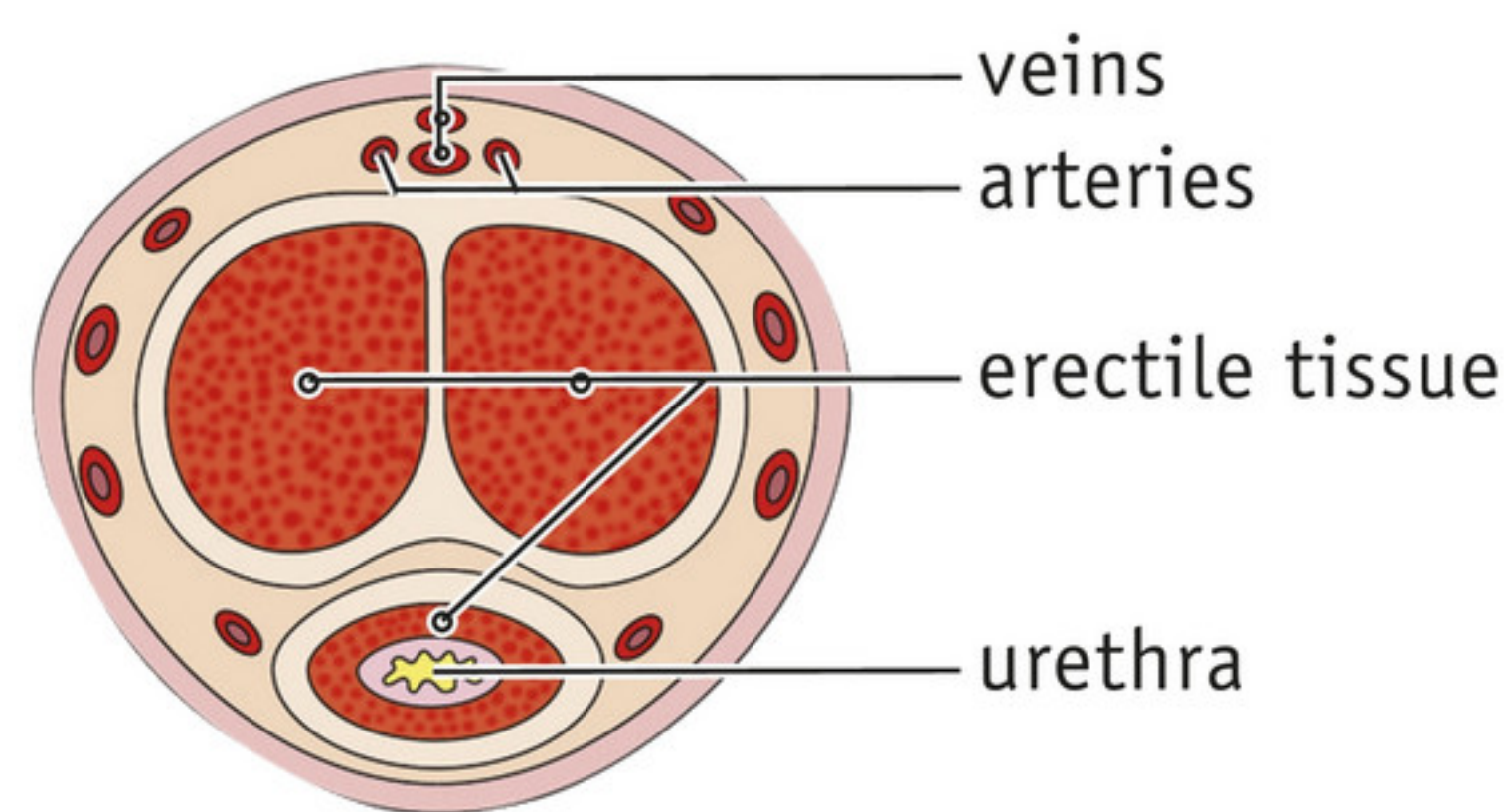
► Fig. 12



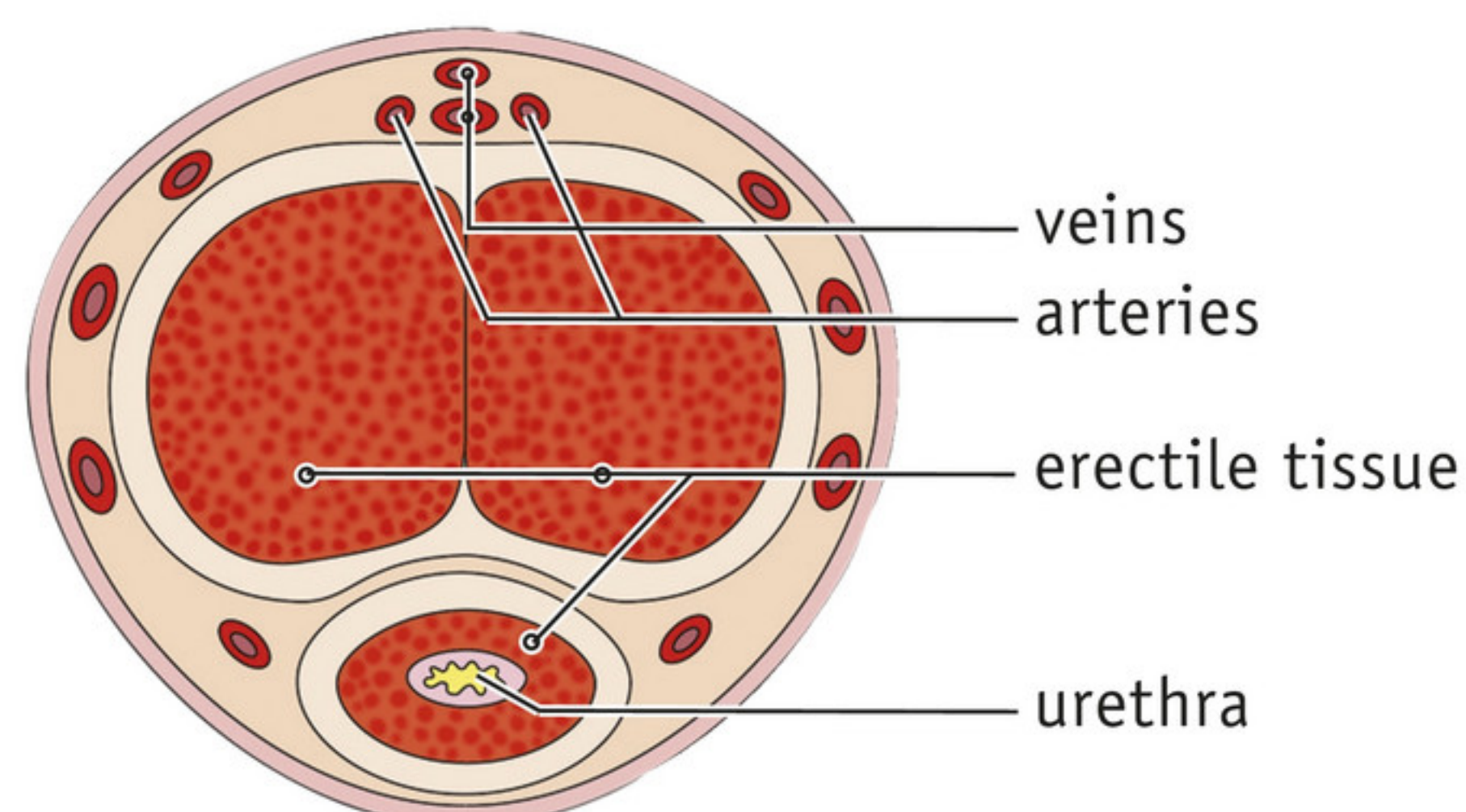
▼ Fig. 13 The penis (external view and cross section).



1 in the normal state (flaccid)



2 erect

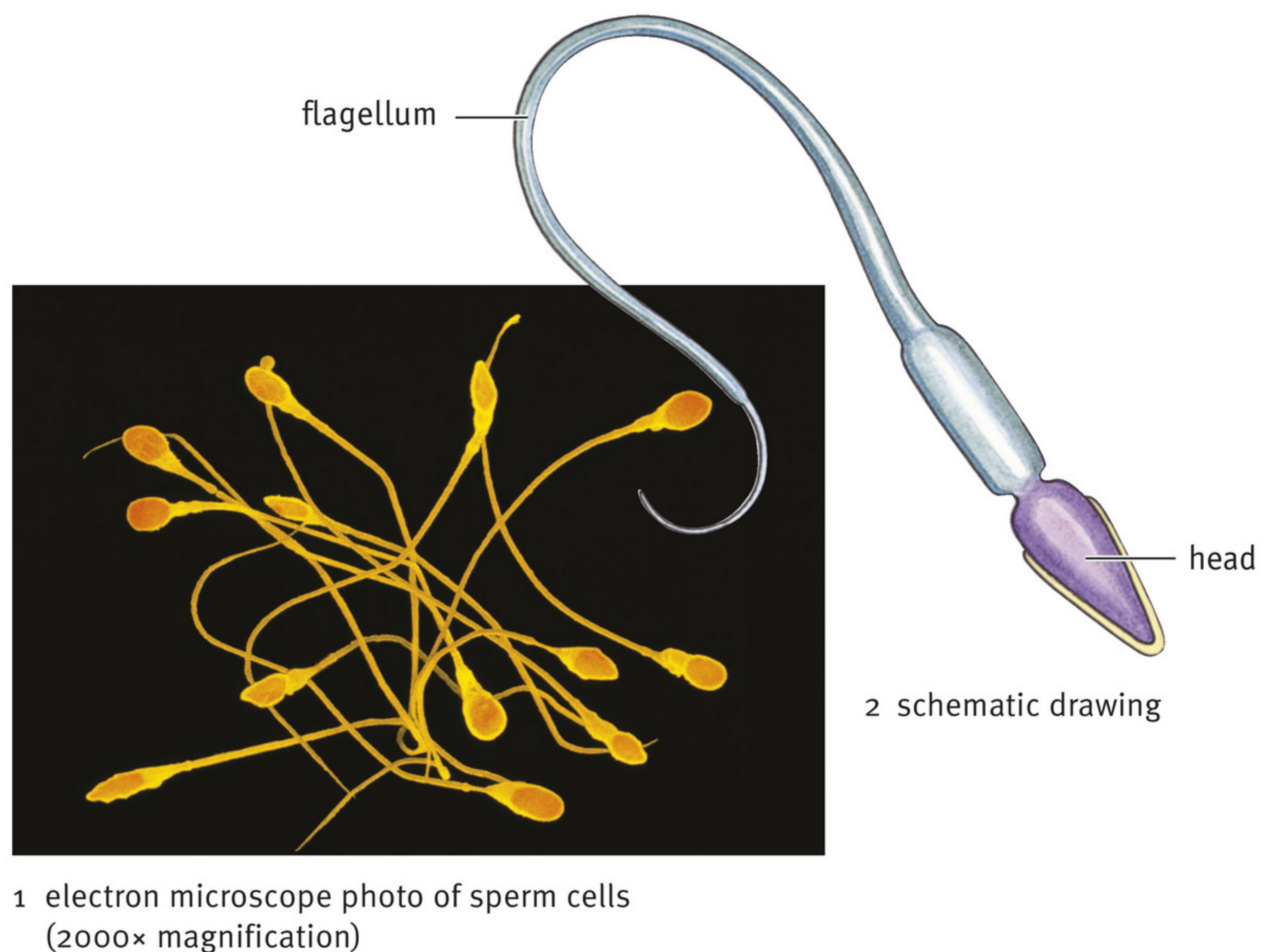


EJACULATIONS

In **sexual intercourse**, a man inserts his penis into a woman's **vagina**. The penis needs to be erect for this. The movements of the man and woman move the penis back and forth inside the vagina. This stimulates the head of the penis continuously. The result is that the man may have an **ejaculation**. The semen then comes out of the penis in spurts. The semen then ends up in the woman's vagina.

About a teaspoonful of semen comes out of the penis in each ejaculation. Semen is sticky and milky white. You have learned that semen consists of a fluid with sperm cells in. A single ejaculation contains 100 to 400 million sperm cells. A sperm cell is very small (see figure 14). It has a tail called a **flagellum** that allows the sperm cell to move.

► **Fig. 14** A sperm cell.



An ejaculation gives a man a pleasant sensation. This is referred to as **coming** or having an **orgasm** or **climax**. A boy or man can also give themselves an orgasm; this is called **masturbation**. A boy or man can get an erection by stroking themselves. Moving the skin of the penis back and forth can result in an ejaculation; terms for this include 'wanking' and 'jerking off'.

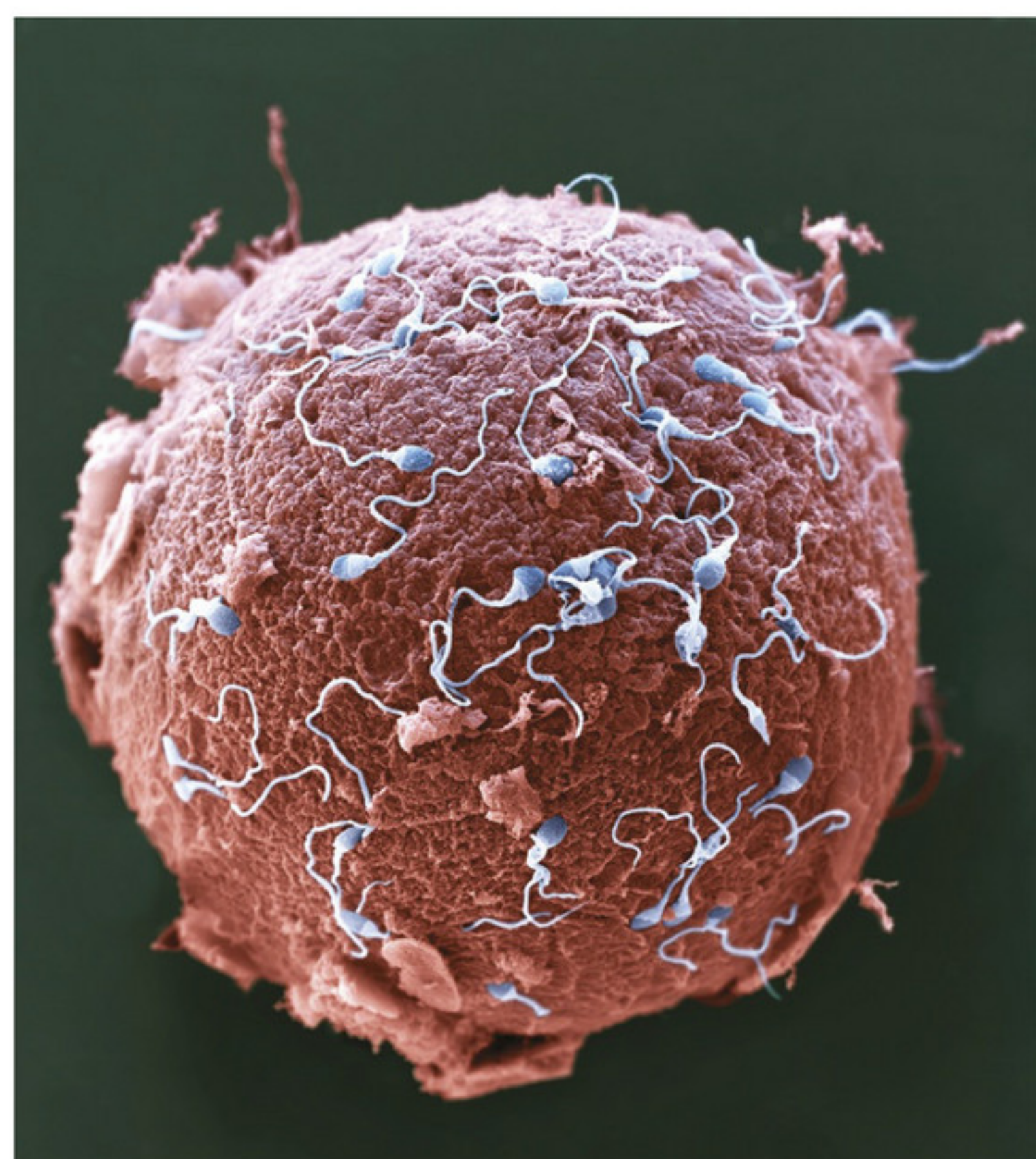
Sometimes an ejaculation can occur spontaneously at night when the man or boy is asleep. This is called a 'wet dream'. On average, a boy's first ejaculation will be when they are aged about thirteen. There are boys who have ejaculations at age 11, and others who do not have their first ejaculation until they are 18.

3 The female reproductive system

▼ Fig. 15

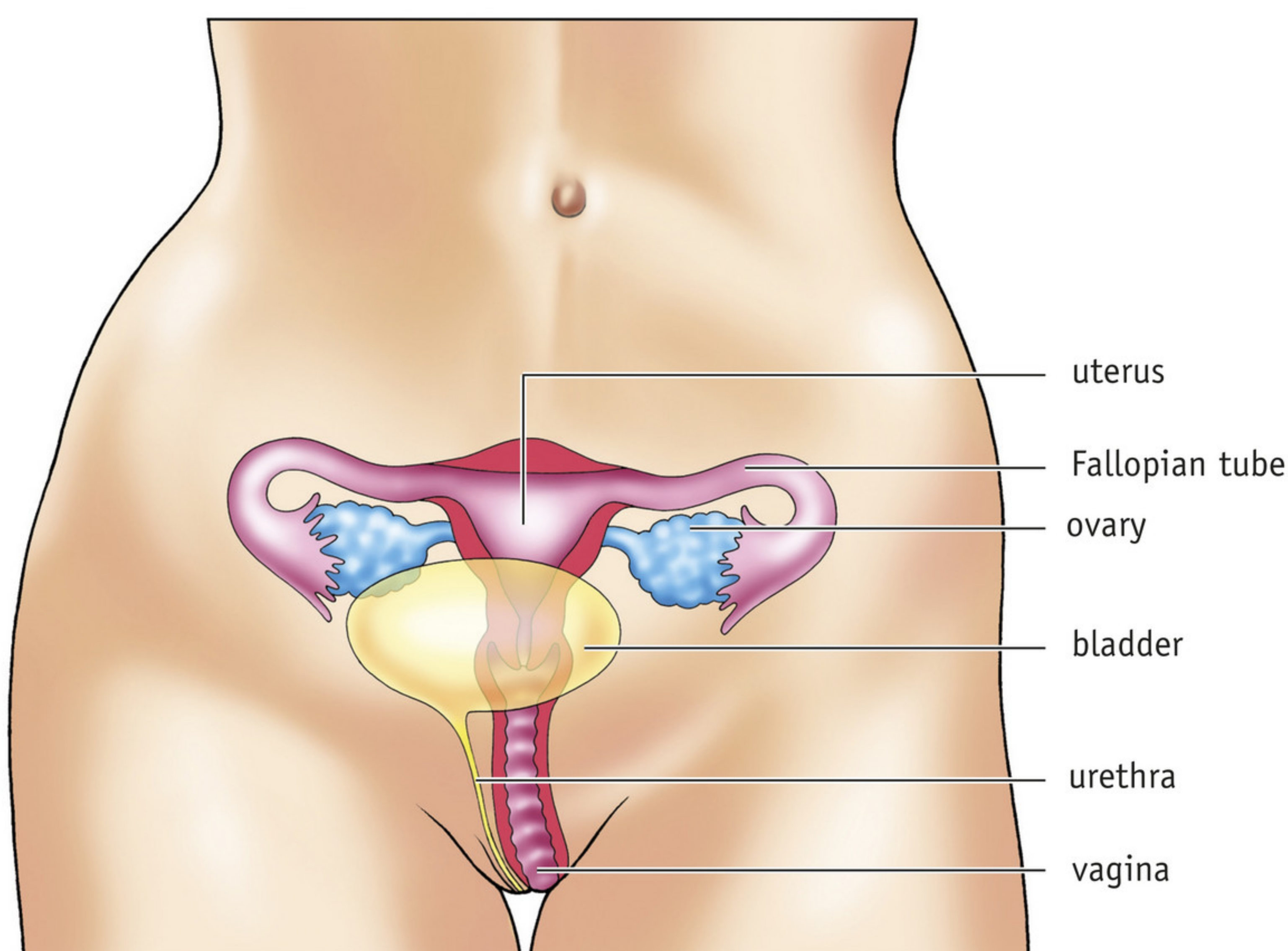


▼ Fig. 17 An egg cell with sperm cells.



Less of the reproductive system can be seen in a woman than in a man (see figure 15). In a woman, most of the sex organs are in the abdomen (see figure 16).

▼ Fig. 16 The female reproductive system (schematic).



The **ovaries** are where the development of the **ova** takes place. Ova are the female sex cells. An ovum (egg cell) is much larger than a sperm cell (see figure 17). This is because an egg cell contains a large food reserve. This spare food is intended for the initial development of the fertilised ovum (the embryo).

Hormones play an important role in the formation of sex cells in girls as well. In puberty, the pituitary gland starts to produce stimulatory hormones. Under the influence of these hormones, the egg cells start developing in the ovaries. When a woman reaches about 50 years of age, less of these hormones are produced. The woman is then said to be in the **menopause**. During the menopause, ova start to develop less frequently. After the menopause, the development of egg cells in the ovaries stops.

OVULATION

From puberty through to the menopause, an egg cell is released from an ovary once every four weeks on average. This is called **ovulation**. Generally, the ovaries will take turns to produce an ovum. The **Fallopian tubes** (or oviducts) carry the egg cells towards the **uterus** (or womb).

After ovulation, an unfertilised egg cell only lives for 12 to 24 hours. After that, it will die and the residues will be absorbed into the bloodstream. This happens in a Fallopian tube. The egg cell can only stay alive for longer if it is fertilised by a sperm cell after ovulation.

FERTILISATION

During sexual intercourse, semen can get into the **vagina**. The sperm cells then move about using the flagellum (tail) towards the uterus and the Fallopian tubes.

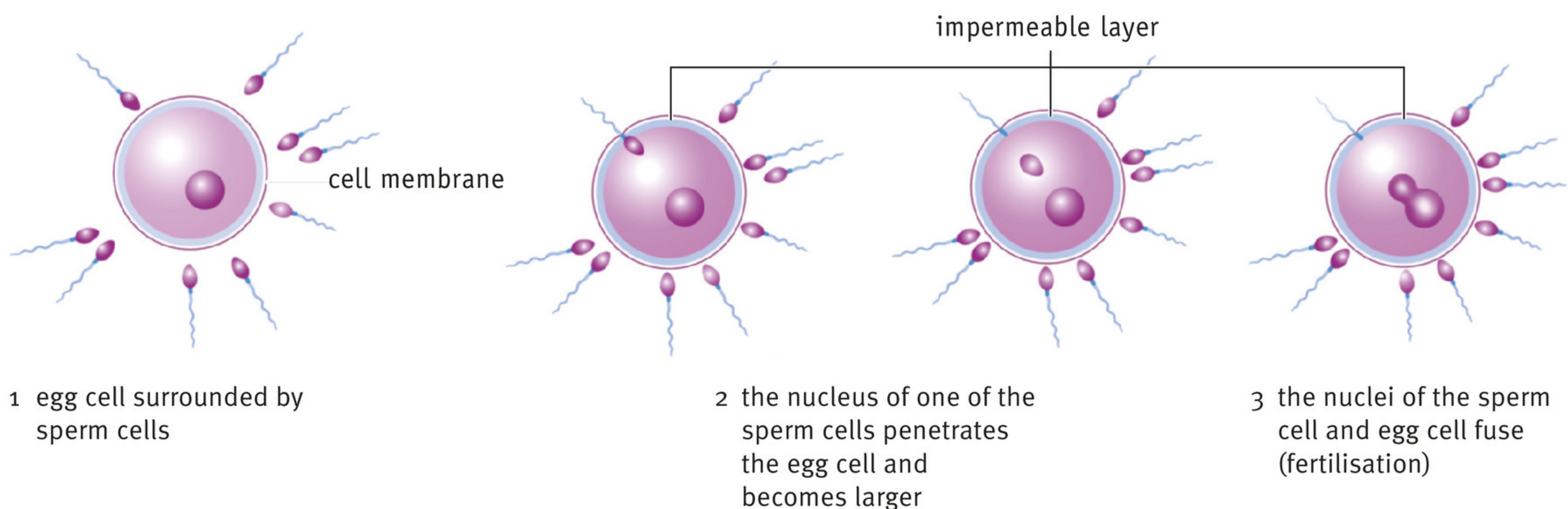
The **fertilisation** of an egg cell by a sperm cell takes place inside a Fallopian tube. During fertilisation, the nuclei of a male sex cell and a female sex cell fuse together.

Fertilisation can occur when the head of a sperm cell penetrates the egg cell (see figure 19). The flagellum of the sperm cell remains outside. Once the head of a sperm cell has entered the ovum, the outer layer of the ovum becomes impenetrable. It is then no longer possible for other sperm cells to penetrate the same egg cell.

▼ Fig. 18



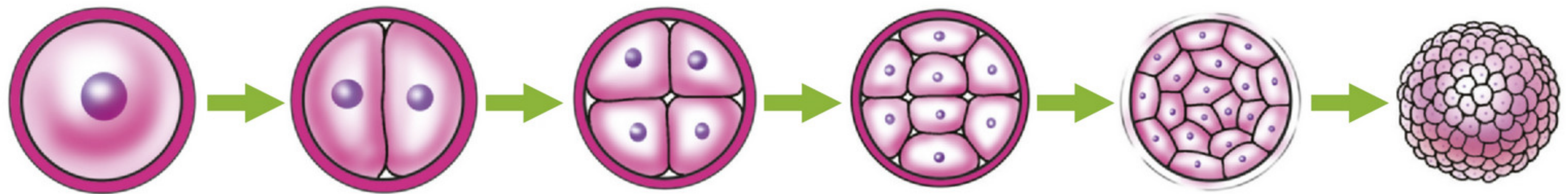
▼ Fig. 19 Fertilisation of an egg cell (schematic).



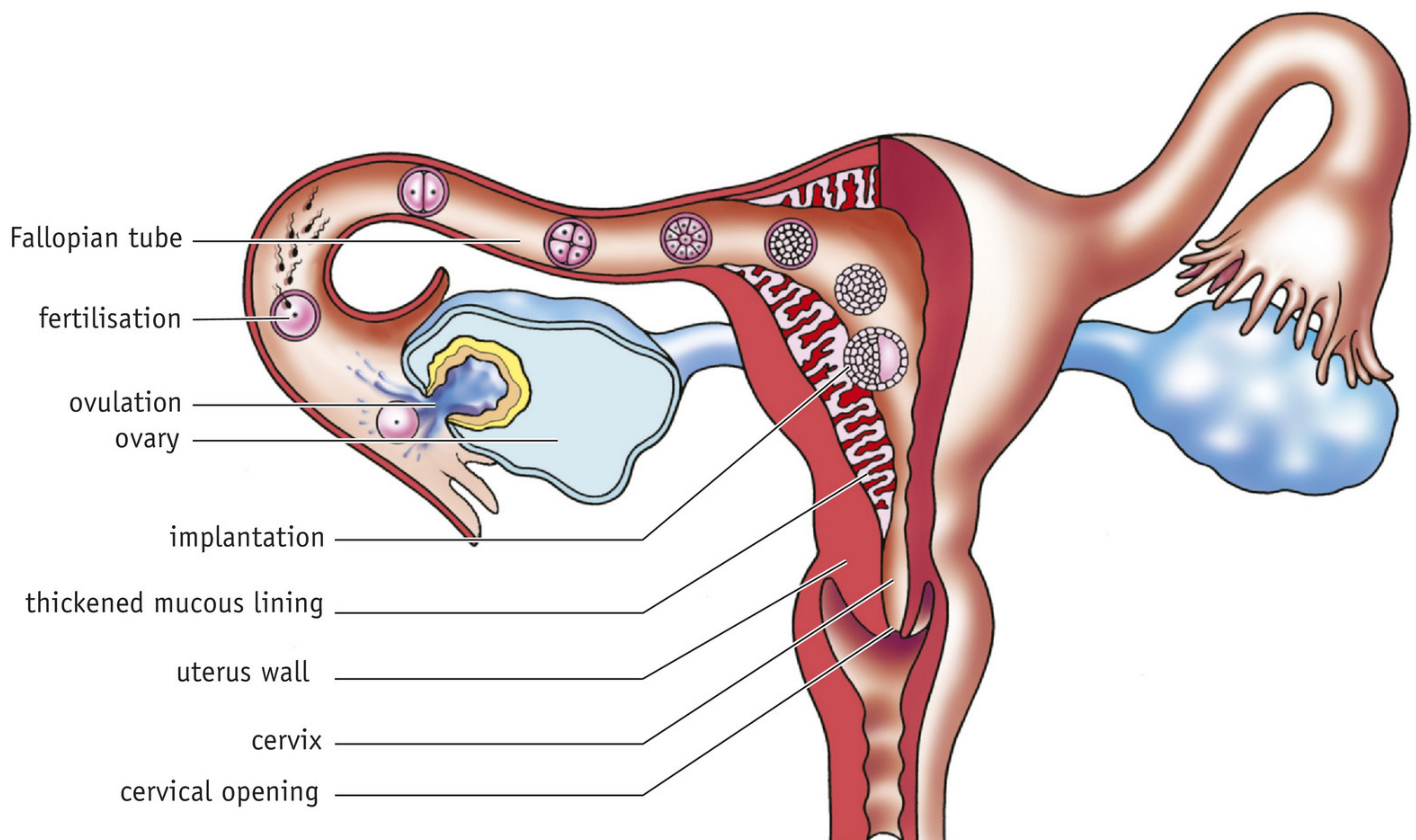
IMPLANTATION

During fertilisation, the nuclei of the sperm cell and egg cell have fused. The fertilised egg cell (embryo) then immediately divides a number of times (see figure 20). The cluster of cells that this produces is carried down the Fallopian tube to the uterus. The wall of the uterus consists of a thick layer of muscle that is covered with a mucous lining on the inside. The uterus lining will have become very thick by this point and contains a lot of blood vessels. The cluster of cells attaches itself to the uterus lining. This is called **implantation** (see figure 21). The woman is then pregnant. Over the course of about nine months, the cluster of cells will grow into a baby. You will learn more about that in basics 7.

▼ **Fig. 20** The first divisions of the fertilised ovum (schematic).



▼ **Fig. 21** The clump of cells is transported to the uterus where it implants in the uterus lining (schematic).

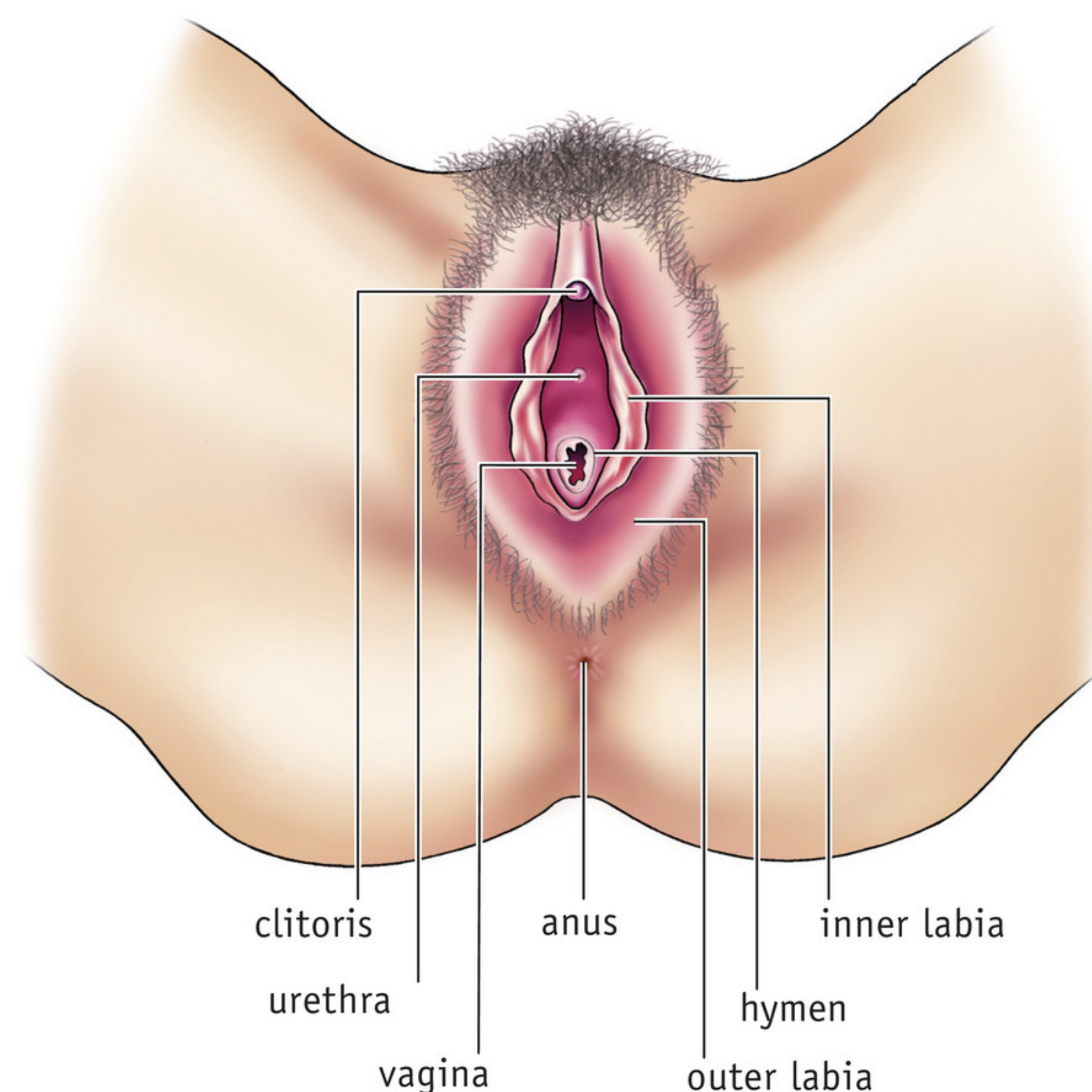


THE EXTERNAL SEX ORGANS OF A WOMAN

In many girls and women, the vagina is not particularly sensitive to sexual stimuli. Most girls and women get an orgasm (climax) when the **clitoris** is stimulated. This can be done by rubbing the clitoris. When the girl or woman does this herself, it is referred to as masturbation. Again, there are other terms for it such as ‘fingering yourself’.

The clitoris is at the front, between the **inner labia** (see figure 22). The urethra exits just behind the clitoris. There are glands in the wall of the inner labia that produce mucus during sexual arousal. This lubricates the entrance to the vagina so that the penis can slide into the vagina more easily. The wall of the vagina is very stretchy. A vagina being too small for a penis is rare; after all, a baby can even get through it during childbirth!

► **Fig. 22** The external sex organs of a woman.



The **outer labia** are outside the inner labia. It is important that the labia are washed properly with water every day. Otherwise mucus may remain between the folds, where bacteria can multiply rapidly. This can cause infections. The inside of the vagina has a mucous lining. At the front of the vagina is the **maidenhead** or **hymen** (see figure 23).

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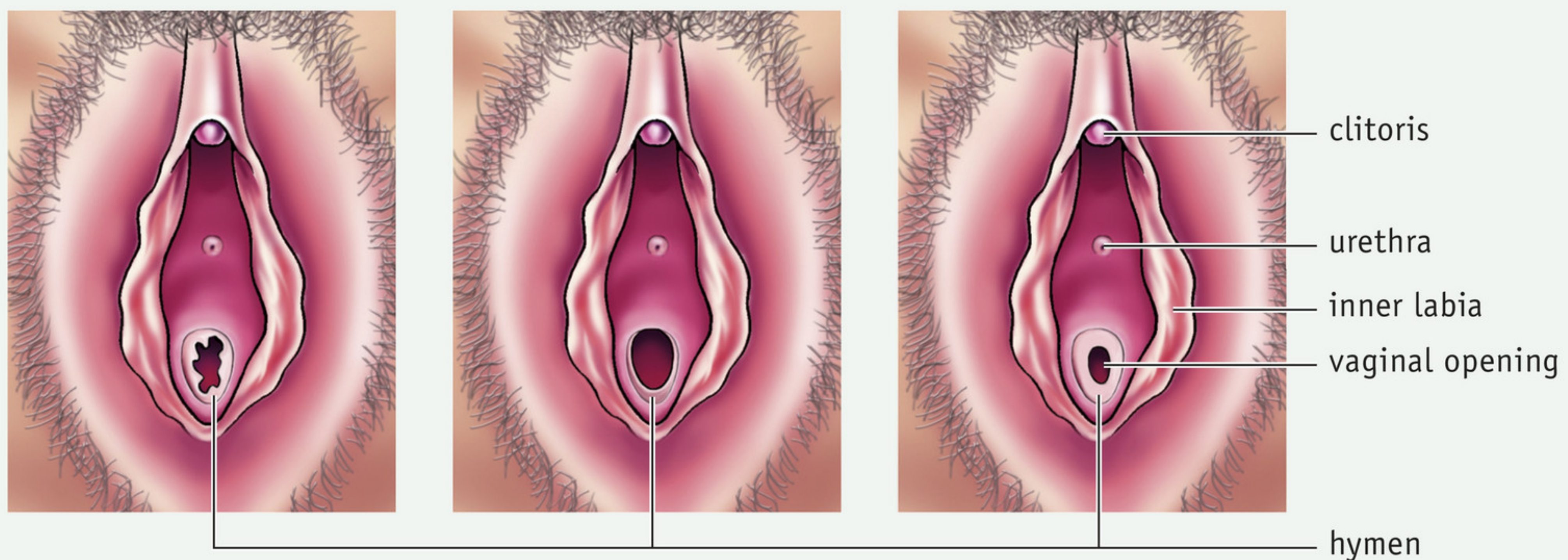
▼ Fig. 23

Hymen

The hymen is a membrane near the entrance to the vagina. Some girls are born without a hymen. If this thin piece of tissue is present, the shape can be quite variable (see the figure).

The hymen, or maidenhead, is therefore not a closed membrane as some people think. These people also think that the penis therefore has to break through the hymen during the first act of intercourse and that this also always means that bleeding will occur, but that is not true.

Most girls and women have no bleeding the first time that they have sex, particularly if they are relaxed and take enough time over the lovemaking. The opening in the hymen will then be large enough to let the penis in. And the vagina will be moist and smooth, so that there will be no tissue damage. In some girls or women, the vagina may tear open a little wider the first time they have sex. A small amount of bleeding can then occur.



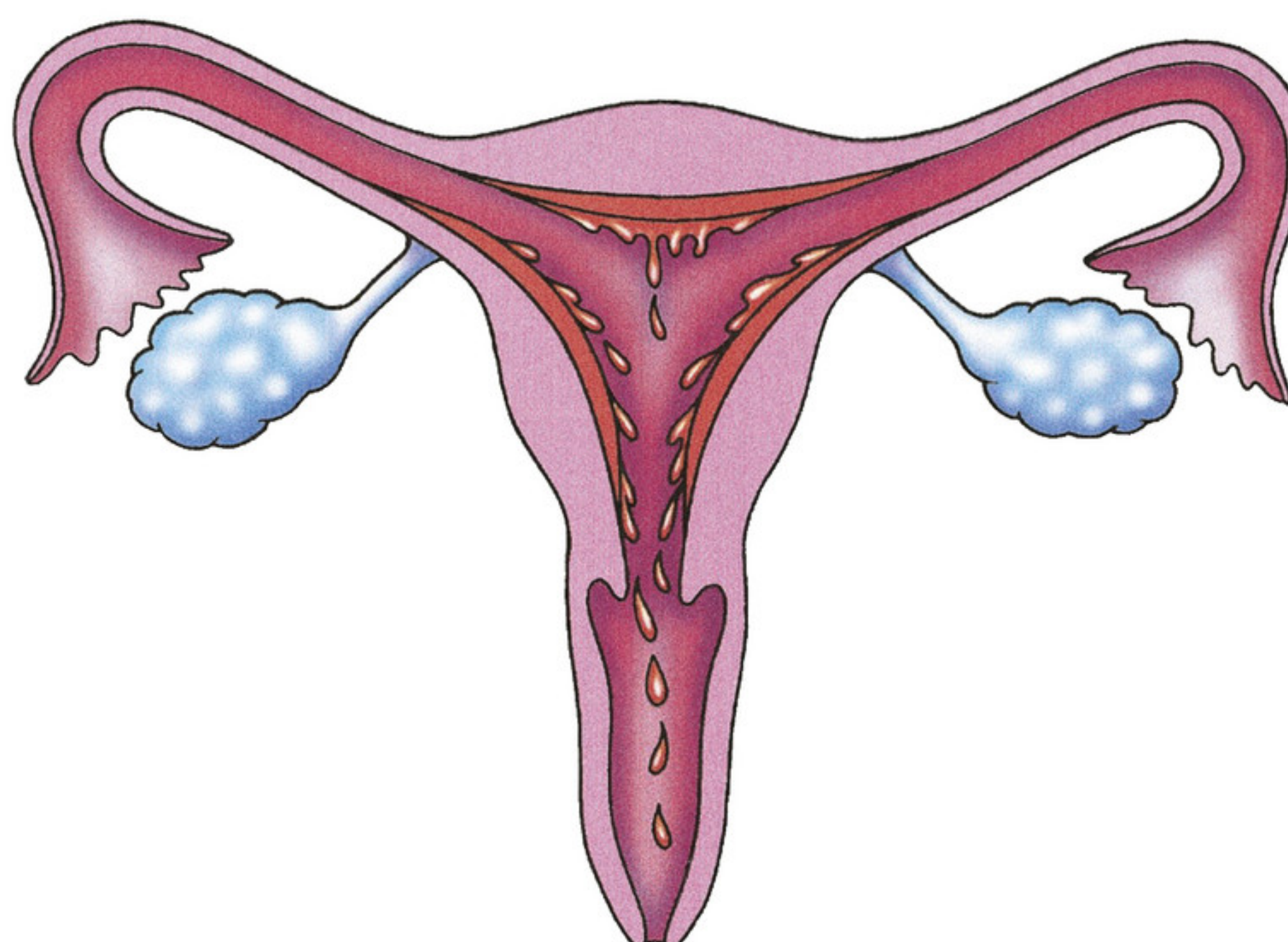
4 Menstruation

You have learned that the uterus lining can become thicker and that it contains a lot of blood vessels. The clump of cells that has become an embryo is able to implant here. If the egg cell is not fertilised, part of the uterus lining detaches. This loss of part of the uterus lining is called **menstruation** or having a **period**. This also releases blood.

Contractions of the muscular layer of the wall of the uterus get rid of the pieces of lining, mucus and blood (see figure 24). These contractions may be felt as abdominal cramps, which can hurt quite a lot.

Many girls and women can feel miserable or sad before and during their period. Some get rather ratty, or may be absent-minded. Or they may sometimes suffer headaches, abdominal pain, back pain or muscle pain.

► **Fig. 24** Pieces of the uterus lining, mucus and blood are carried away during menstruation (schematic).



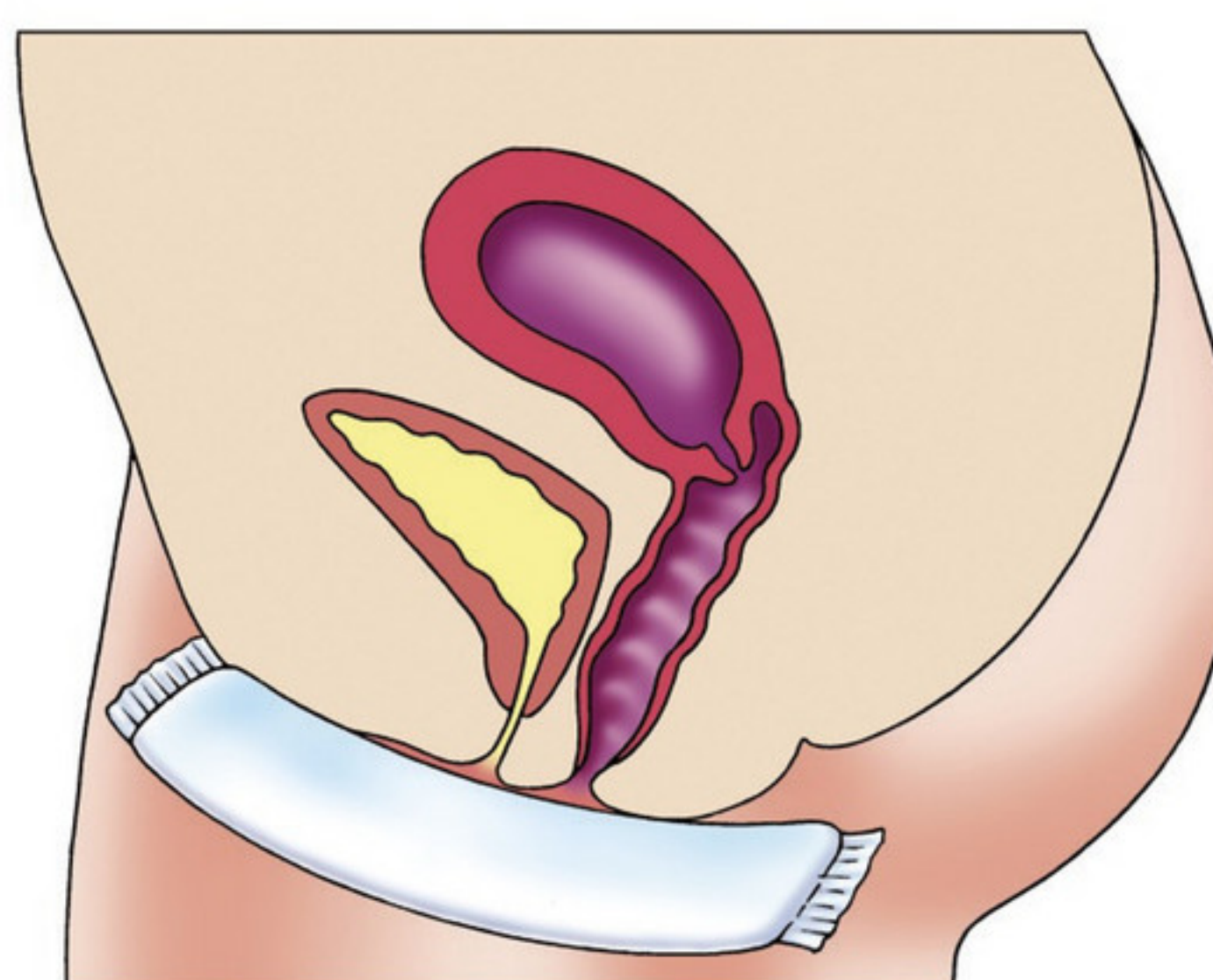
▼ **Fig. 25** Pads and tampons.



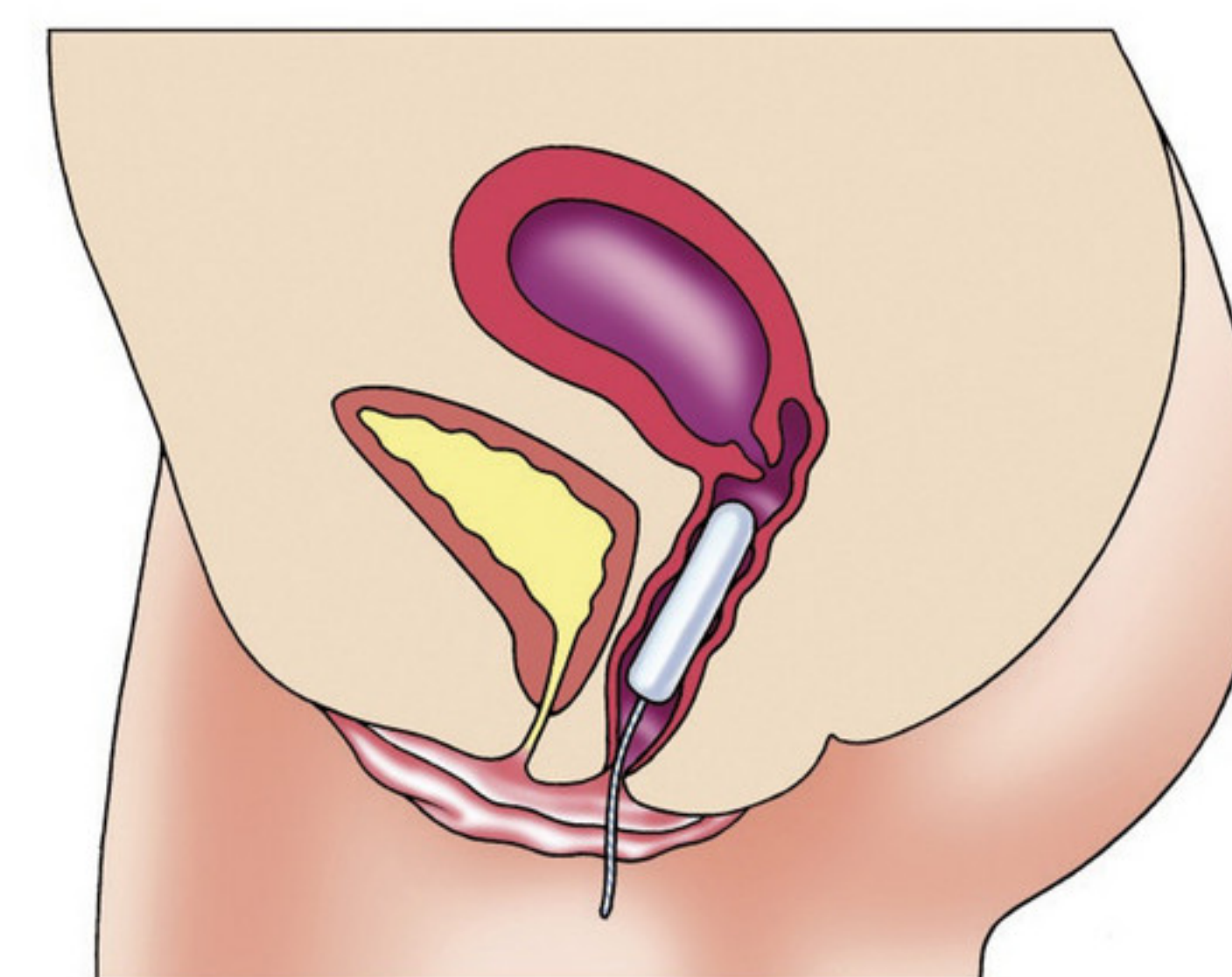
Girls start to menstruate at age 13 on average. There are some girls who may menstruate as early as 10 years of age, and others for whom it may not happen until 16. Menstruation stops during the menopause. In some girls and women, the menstruation may only last about three days. For others, menstruation can last a week.

During menstruation, girls and women mostly use **pads** or **tampons** (see figure 25) to catch the residues of the uterus lining and blood. Pads are worn up against the opening of the vagina (see figure 26.1), whereas tampons are placed inside the vagina (see figure 26.2).

► **Fig. 26**



1 how to use pads



2 how to use a tampon

Pads and tampons can only absorb a limited amount of fluid. Bacteria can make the blood smell bad and infections can occur. Both pads and tampons therefore need to be changed regularly. It is also important that a girl or woman washes properly between the labia during menstruation in particular. Use plenty of water for washing, but little or no shower gel or soap. Shower gel and soap can irritate the skin and even cause infections.

THE MENSTRUAL CYCLE

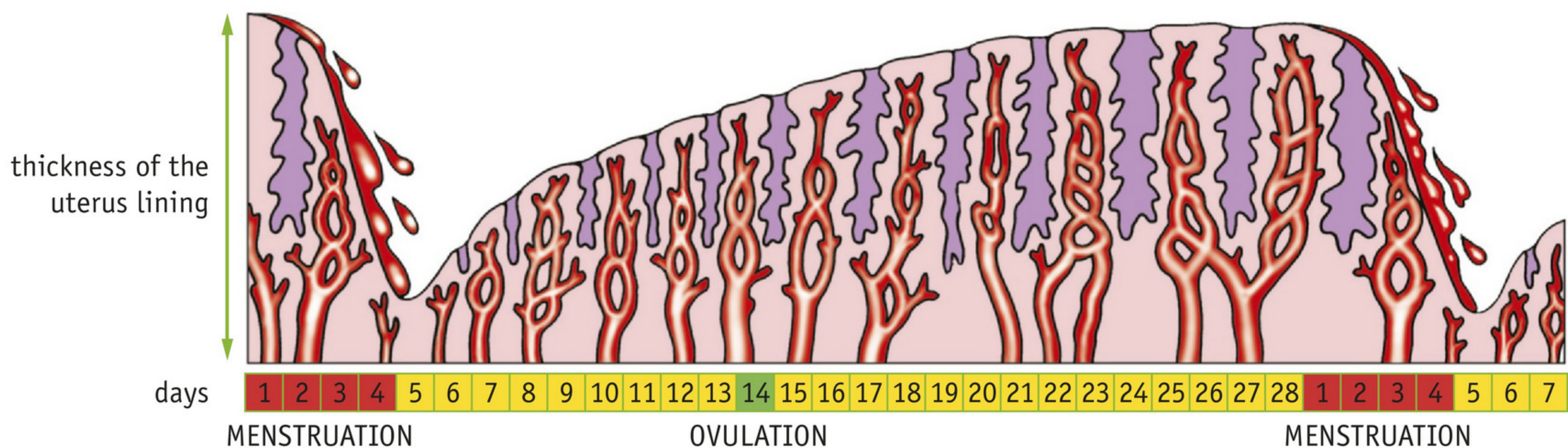
Figure 27 is a diagram showing the thickness of a woman's uterus lining over the course of five weeks. During menstruation, part of the uterus lining is lost. The uterus lining then begins to grow thicker again and will contain more blood vessels.

Ovulation occurs roughly fourteen days after the start of menstruation. In the absence of fertilisation, the next menstruation will begin about 28 days after the previous one. We say that the **menstrual cycle** is starting again.

There are not many women who menstruate absolutely regularly, every four weeks. In many women, the periods are more irregular. Sometimes the next period will come after just three weeks, or sometimes it can take five. Particularly during the first years that a girl is menstruating, her periods may be irregular.

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▼ **Fig. 27** The uterus lining of a woman over the course of five weeks (schematic).



5 Sexuality

Sexuality starts to appear in puberty and will then play an increasingly important role in your life. Sexuality also plays an important role in the lives of adults. People can have very different opinions about it. Sexuality can therefore also play a role in someone's life in a variety of ways.

MAINTAINING A SPECIAL RELATIONSHIP

Sexuality can play a role in **maintaining a special relationship**. If you love someone especially, you will want to make that clear to them regularly. For example by touching and cuddling them. And if you love someone a lot, you may want to make love or have sexual intercourse with them.

People have various different ideas about sexuality. Some people want to have a long-term relationship before they have sexual intercourse. For other people, a steady relationship is not so important. And there are other people who want to be married before they have sex.

LIBIDO

Sexuality can give people a lot of pleasure, for example because it arouses them ('turns them on'). This is referred to as **libido** or sex drive. You may become sexually aroused by lovemaking or sexual intercourse with someone you feel strongly attracted to. You may also be aroused sexually by looking at photos or videos of people who are naked or having sex.

Photographs or videos that are intended to stimulate people sexually are called **pornography (porn)**. This often involves clear pictures of the sex organs. Watching a lot of pornography can create an unrealistic image of sexuality. Pornography is often unfriendly to the female characters and generally has little to do with genuine sex within a relationship; more often, it expresses a particular kind of male fantasy.

A **prostitute** (whore, hooker) is someone who is prepared to have sexual intercourse with a customer for money. Prostitution is forbidden for minors.

► **Fig. 28** Sexuality and libido.



REPRODUCTION

A man and a woman can have sexual intercourse. This may result in a baby being born. So sexuality plays a role in **reproduction**. Many people do however have sexual intercourse without wanting a child. In that case, they use **contraceptives**.

DIFFERENT SEXUAL PREFERENCES

There is a variety of sexual preferences. We shall list a few here. The majority of people feel sexually attracted to people of the other sex. These people are **heterosexual** (hetero = not the same).

About 5% of people are **homosexual** (homo = the same). Homosexuals feel sexually attracted to people of the same sex. Homosexual girls and women are also referred to as **lesbian**.

People who feel sexually attracted to both sexes are called **bisexual**.

▼ **Fig. 29** Differences in sexual preference.



1 heterosexual



2 homosexual



3 lesbian

▼ **Fig. 30** A person with an androgynous appearance.



The term **transgender** is used for people who (sometimes) do not identify with the gender they were born with: a person with the body of a boy who feels more as if they are a girl, or the other way round. A **transvestite** is someone who dresses for longer or shorter periods as someone of the other sex. A **transsexual** is someone who would like surgery to change their body to the gender they want, or who has already done so. An **androgynous** appearance means having external features of both sexes (see figure 30). A person may also feel androgynous: both male and female at the same time.

The majority of Dutch people accept these variations in sexuality and sexual preference. Nevertheless, lesbians, homosexual men, bisexuals and transgender people still have to put up with discrimination, bullying, intimidation or even violence. A lot of people are ready to protest against this (see figure 31).

▼ Fig. 31

Record number of schools take part in Purple Friday

More than 500 of the roughly 680 secondary schools in the Netherlands took part in Purple Friday. Pupils at more schools than ever were joining in this annual campaign to fight homophobia and discrimination against homosexuals, bisexuals and transsexuals at school. Purple Friday is held every year on the second Friday in December. It is organised by the Gay-Straight Alliance (GSA) network. A GSA is a group of heterosexual, lesbian, homosexual, bisexual and transgender pupils who take action at their school to create a safer climate for lesbian, homosexual, bisexual and transgender people.

Source: www.coc.nl.



A HEALTHY SEXUAL RELATIONSHIP

No matter what kind of relationship you have, a 'healthy' sexual relationship means openness, equality, intimacy and respect for each other. If there are large differences within a relationship, it will not be a relationship of equals. They may for instance be large differences between the partners in terms of age, experience, intelligence and available income. Power differences such as these can easily be misused and lead to sexual violence.

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SEXUAL VIOLENCE

Sex can be very nice, if it is what you want. It is also possible that someone may force you into sexual contacts. This is called **sexual violence**. The victim then suffers sexual abuse (see figure 32). Sexual violence is forbidden by law and can result in prison sentences for the perpetrators. Forced sex with other members of the victim's family is called **incest**.

▼ Fig. 32

Sexual violence: three pupils per class

Studies by the Rutgers Nisso Groep have shown that over 16% of girls and 4 to 5% of boys aged between 14 and 18 have been affected by sexual violence. That means that an average of three pupils in every fourth-year class in secondary education have been victims of it.

Sexual violence can take many different forms. It can range from someone being repeatedly kissed when they do not want it, for example, through to being forced to have sexual intercourse. Sexual violence can also involve webcams. A former boyfriend may for example threaten to post nude photos of a girl on the Internet if she does not do what he wants.

Victims of sexual violence often suffer from emotional or physical problems. The Rutgers Nisso Groep has therefore started a collaboration with Interapy, a website offering psychological treatment (www.interapy.nl) where young people who have been affected by sexual violence can now also get free help.



sexual violence can also involve the Internet

Minor sexual acts with another person against their will (for example grabbing them or pinching their bottom) are known as **sexual harassment**. **Sexual assault** refers to sexual activities performed with the victim with violence or threats. **Rape** involves sexual intercourse as well.

A **loverboy** is someone who starts by 'grooming' a girl – being very nice to her and tempting her with attention and expensive gifts. A loverboy then makes sure that the girlfriend has no other contacts and he gains power over her, with the aim of forcing her into prostitution so that he can earn a lot of money from her.

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6 Birth control

Birth control means that a woman – usually together with a man – decides whether she wants a baby or not. If the woman does not want to become pregnant, she or the man can use **contraceptives**. They then share the responsibility for using a reliable method of contraception. The two best-known contraceptives are condoms and ‘the pill’. The pill in particular is reliable. You can learn more about other reliable methods of contraception in extra section 9. However, there are also unreliable methods of avoiding pregnancies.

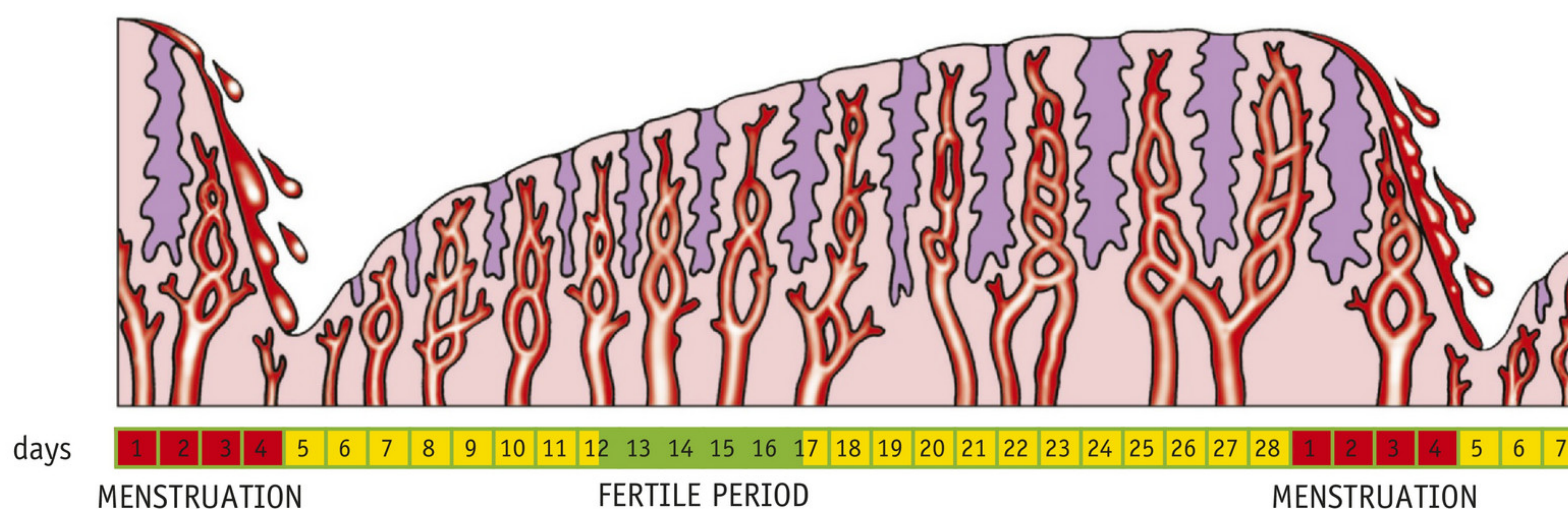
► Fig. 33



UNRELIABLE METHODS

You have learned that an unfertilised egg cell only lives for 12 to 24 hours after the ovulation. Sperm cells can continue to live inside a woman’s body for two to three days after the ejaculation. So there is only a relatively short period of about four days every four weeks when sexual intercourse is likely to result in an egg cell being fertilised. This ‘fertile period’ is from about three days before ovulation to about one or two days after ovulation (see figure 34).

► Fig. 34



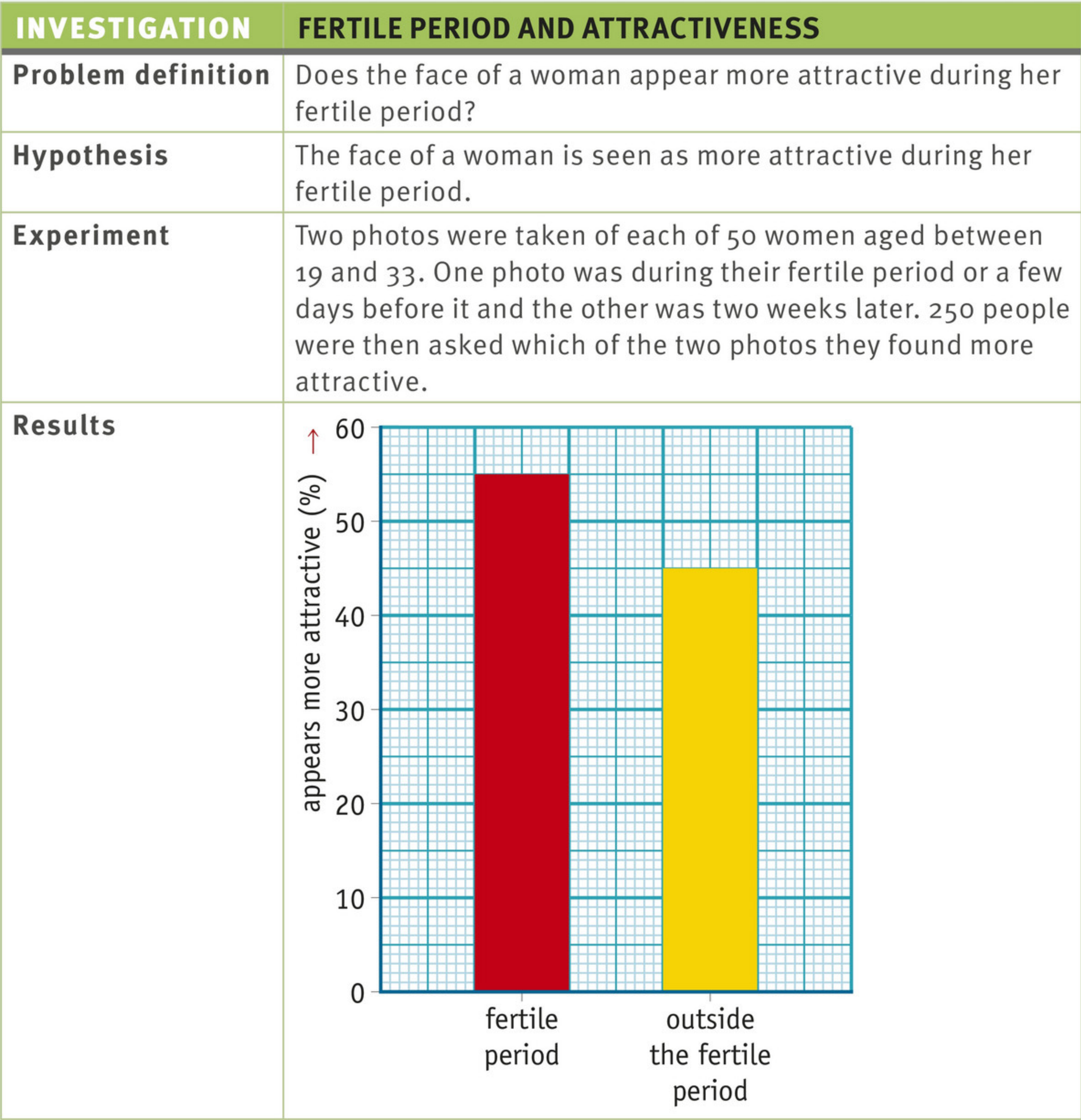
Biologists have examined whether a woman’s face becomes more attractive during her fertile period (see figure 35).

▼ Fig. 35

Does the fertile period make people attractive?

In many animals, the start of the female’s fertile period can clearly be seen. In chimpanzees, for example, you can see that the sexual organs become swollen and redder (see photo). But that is not so clear in humans. Or maybe it is, just a little? Researchers at Newcastle

University wondered whether the attractiveness of female faces might change during the menstrual cycle. Might the face of a woman be seen as more attractive during her fertile period?



One of the oldest ways of preventing pregnancy is periodic abstinence: the **rhythm method**. The man and woman do not have sexual intercourse during the ‘fertile period’ of about six days. You cannot generally determine precisely when the ovulation will take place. Some women’s ovulations occur earlier or later than the average. The rhythm method is therefore very unreliable. Women who menstruate irregularly can easily end up with an unwanted pregnancy if they use this method.

In **coitus interruptus** (the **withdrawal method**), the man removes his penis from the vagina when he feels his orgasm is about to happen. Ejaculation then takes place outside the vagina. However, it is possible that some fluid may already have come from the penis before the actual ejaculation; this pre-ejaculation fluid often also contains sperm cells. That means that this method is also very unreliable.

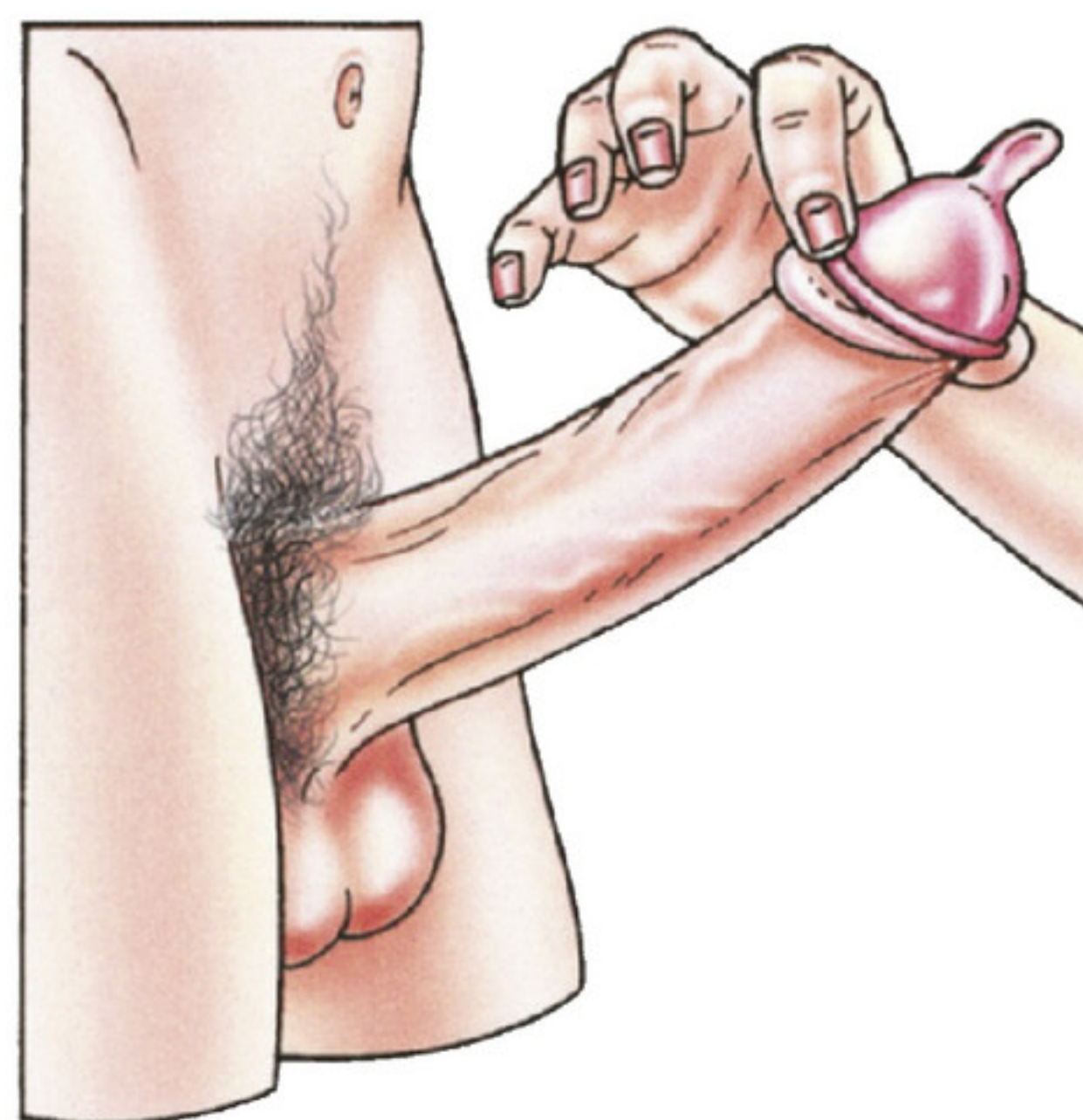
► Fig. 36



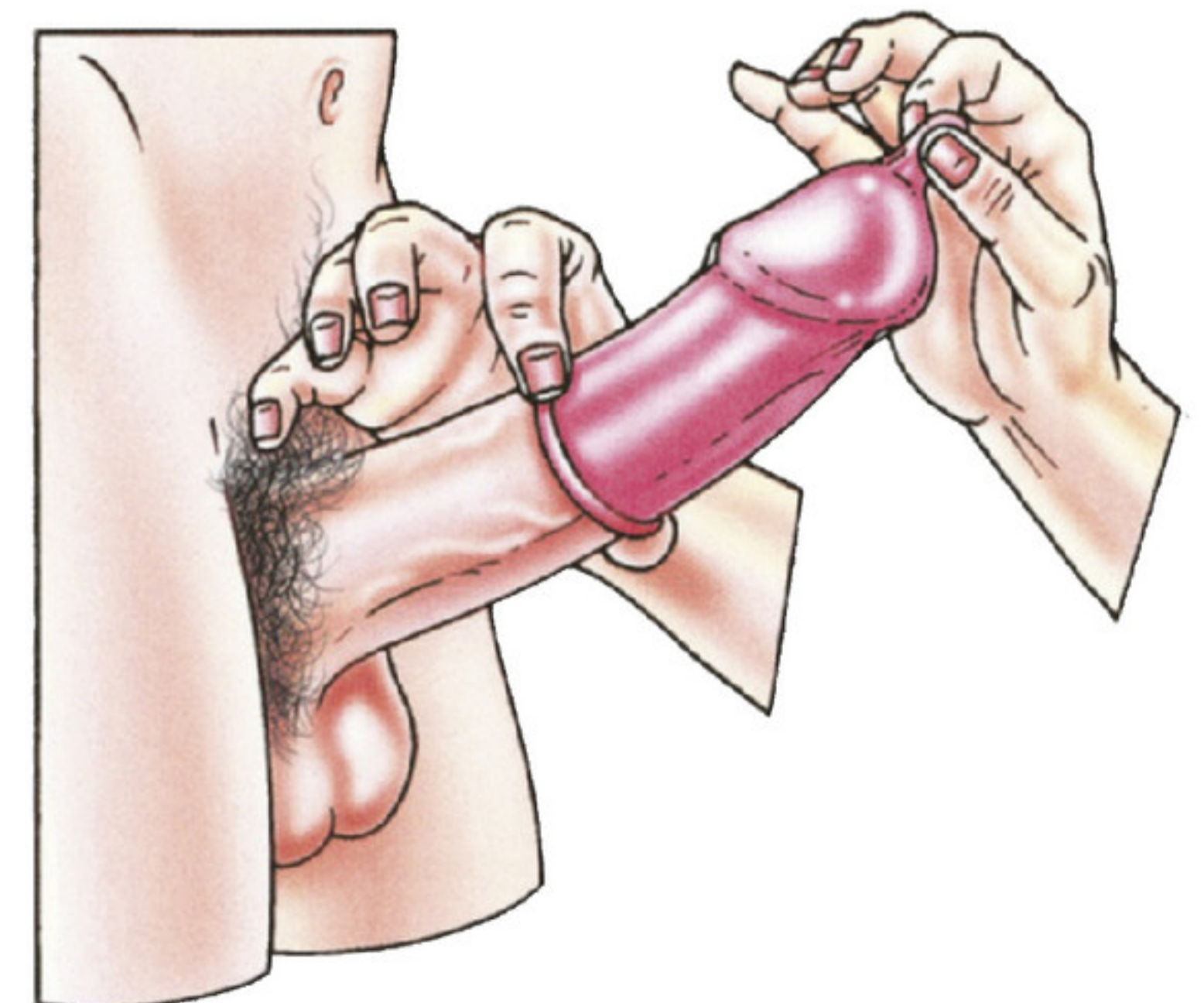
THE CONDOM

A **condom** is a latex sheath that is placed on the erect penis (see figure 37). A condom prevents semen from getting into the vagina.

▼ Fig. 37 Using a condom.



1 put the condom over the head of the penis



2 pinch the top of the condom with your fingers and roll it down over the penis with the other hand

Condoms are simple, cheap and reasonably reliable. You can only use each condom once. A disadvantage is that the lovemaking has to be interrupted in order to put the condom on. A benefit is that a condom provides protection against the transmission of bacteria and viruses. The AIDS virus can be transmitted by sexual intercourse, for example, if no condom is used. Basics 8 tells you more about the AIDS virus and other diseases that are related to sexual activity.

Only use condoms that have a CE safety mark (see figure 38.2). And be careful to observe the expiry date stated on the packaging. Novelty condoms (see figure 39.2) are made for fun and amusement and are not suitable for safe sex.

▼ Fig. 38



1 condoms



2 CE safety marking

▼ Fig. 39 Condoms that are not suitable for safe sex.



1 the biggest condom in the Netherlands



2 fun condom

THE PILL

The **pill** (the **contraceptive pill**) is the most widely used method of contraception. The pill contains hormones that trigger a number of changes in the woman's body. As a result of these hormones, ovulation does not take place and no ova are released.

The pill has to be taken every day, usually with a break of one week in every four. Menstruation takes place during the week with no pills. The menstruation is then not as heavy as when you are not on the pill. For this reason, the pill is sometimes also prescribed for girls or women who have very painful or irregular periods.

The pill is a highly reliable method of contraception. The tablets come in a blister-strip pack on which the days of the week are marked (see figure 40).

This means that a girl or woman can immediately see if she has forgotten to take the pill one day. In that case, continuing to take it until the next menstruation often does *not* offer reliable protection against pregnancy.

The pill is only available with a doctor's prescription. This means that the doctor may want to examine the pill user regularly. Using the pill does sometimes have side effects, such as nausea, headaches, weight gain or a feeling of tension in the breasts. Those complaints generally pass within three months. If necessary, the doctor may prescribe a different pill.

▼ **Fig. 40** Various types of contraceptive pills.



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EMERGENCY MEASURES AGAINST UNWANTED PREGNANCY

Sometimes something goes wrong. A woman may realise after sexual intercourse that she had forgotten to take the pill. Or a condom can tear or slip off. In such cases, emergency measures are possible to prevent a pregnancy. These measures are also used in cases of rape.

The **morning-after pill** (see figure 41) is a pill that contains large amounts of hormones. The pill must be taken within three days (72 hours) after sexual intercourse. The morning-after pill works best if it is taken within 12 hours after sex. A woman who takes the morning-after pill may be very nauseous. She should then be careful to check that the pill is not vomited back up if she is sick. The morning-after pill can be obtained without a prescription from drugstores and pharmacies, but should not be used too often.

If a girl or woman becomes unintentionally pregnant, she may be faced with an awkward dilemma. Does she want to bring the child up herself? Would she want to have it fostered or given up for adoption? Or does she want to terminate the pregnancy? And can she take that decision together with the child's biological father? In the Netherlands, FIOM (www.fiom.nl) can provide support for a woman in making this decision.

▼ **Fig. 41** Morning-after pill.



If a woman chooses to terminate her pregnancy, she can ask for an **abortion**. An **abortion pill** can be taken up to the seventh week of the pregnancy, but there are often medical reasons why this method cannot be used.

The commonest form of abortion is called **vacuum aspiration** (see figure 42). A woman can have a vacuum aspiration performed until the thirteenth week of pregnancy. Under local anaesthesia, a suction pump is used to remove the uterus lining plus embryo, via the cervix.

If the pregnancy is to be terminated after the thirteenth week of pregnancy, a more serious intervention is required (**late abortion**). This method may be used up to the twenty-third week of pregnancy. Abortions are free in the Netherlands.

If a woman wants an abortion, she must first discuss it with a doctor and a nurse or social worker. After this discussion, there is an interval of five days during which she can think about it. This interval is legally required.

► **Fig. 42** Vacuum aspiration.



Views on abortion (and other emergency measures) vary widely. Some people think that the woman has every right to be the 'boss of her own body' (see figure 43.1), whereas others put it in terms of the murder of an unborn child (see figure 43.2). There are also others for whom it depends on how the girl got pregnant: she may have slept with someone of her own free will, which they see as different from becoming pregnant for example as a result of being raped.

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► **Fig. 43** Various positions adopted about abortion.



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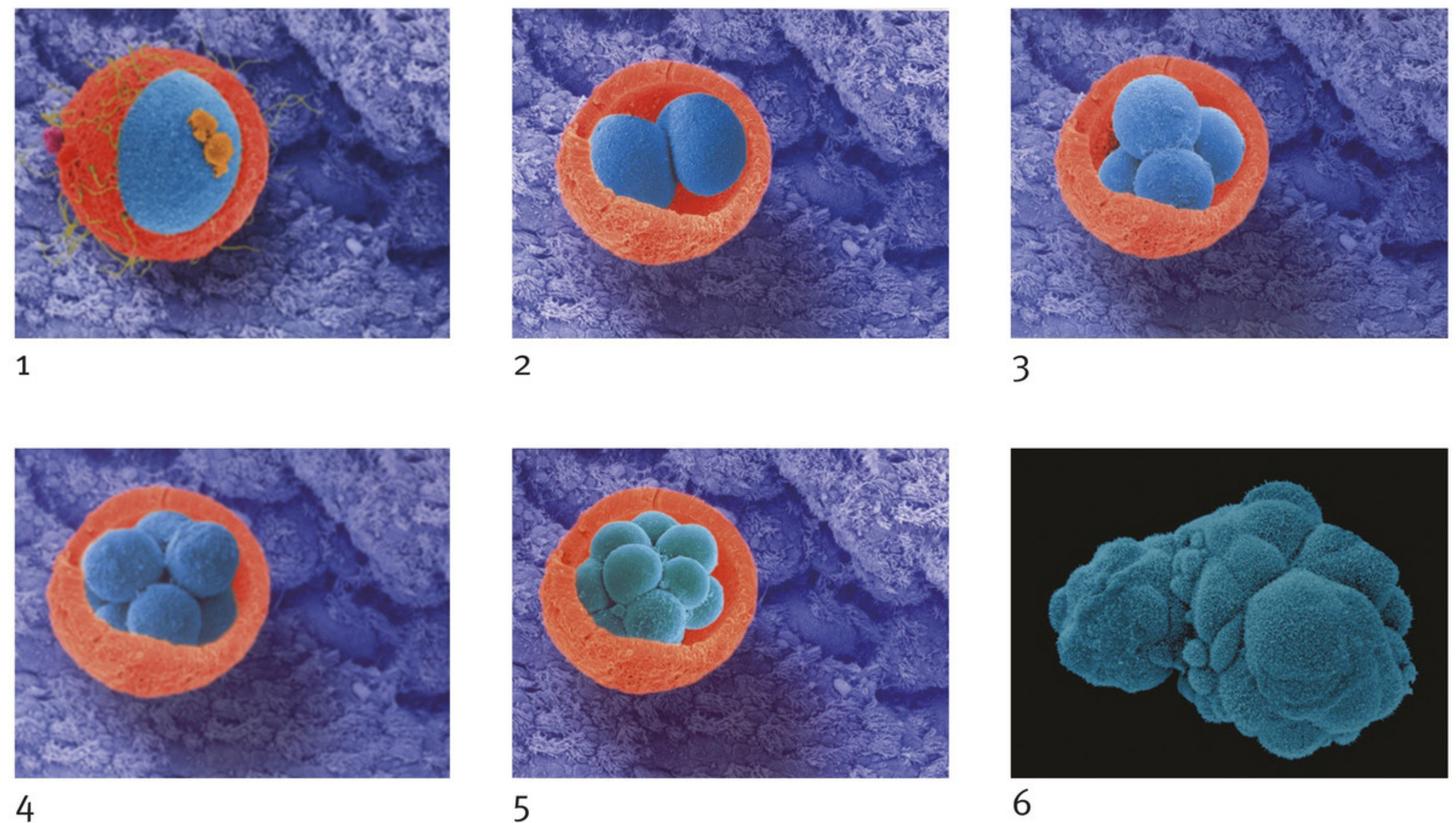
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7 Pregnancy and childbirth

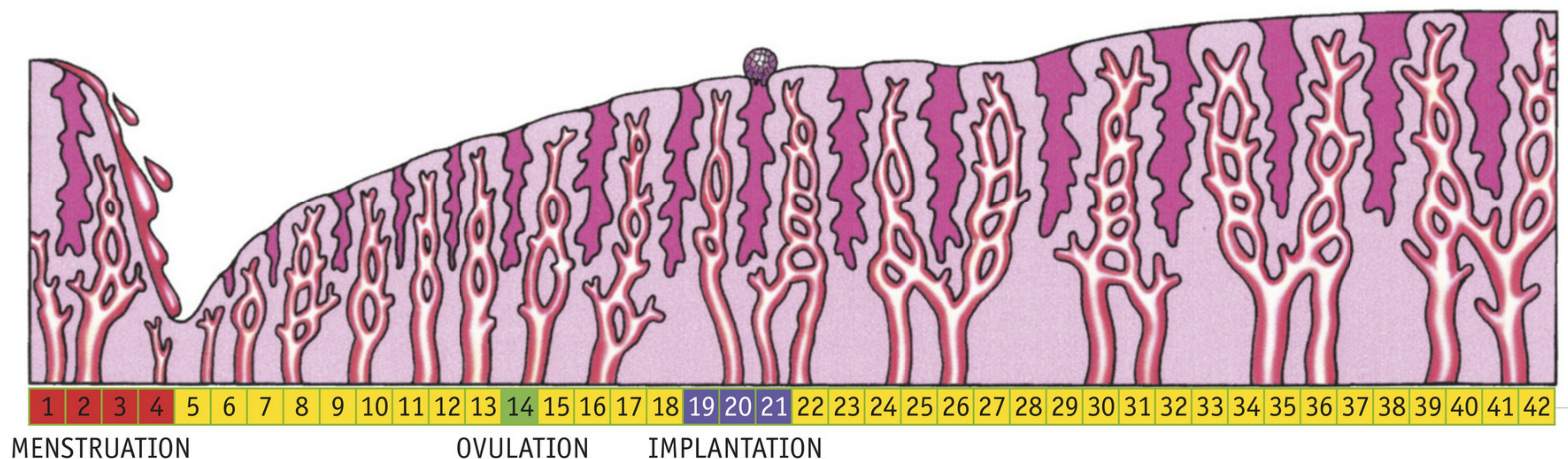
You have learned that an egg cell that has been released can then be fertilised in the Fallopian tube by a sperm cell. The fertilised egg cell then starts to divide immediately (see figure 44). The cluster of cells that this produces – the embryo – is carried down the Fallopian tube to the uterus, where **implantation** in the uterus lining can then occur. The uterus lining will in that case not become detached and there will be no menstruation. The woman is pregnant.

Figure 45 is a diagram showing the thickness of a woman's uterus lining over time when she becomes pregnant. The implantation of the embryo takes place five to seven days after ovulation. That cluster of cells grows to become a baby. The child is born about 38 weeks after fertilisation.

▼ **Fig. 44** Division of the fertilised ovum (microscope photos).



▼ **Fig. 45** The uterus lining in a woman who is pregnant (diagram).



▼ Fig. 46 Pregnancy test.



Simple tests can be bought from a drugstore or pharmacy that will let a girl or woman determine if she is pregnant (see figure 46). A positive result in particular is highly reliable. The GP or a doctor at a health centre can also do a test.

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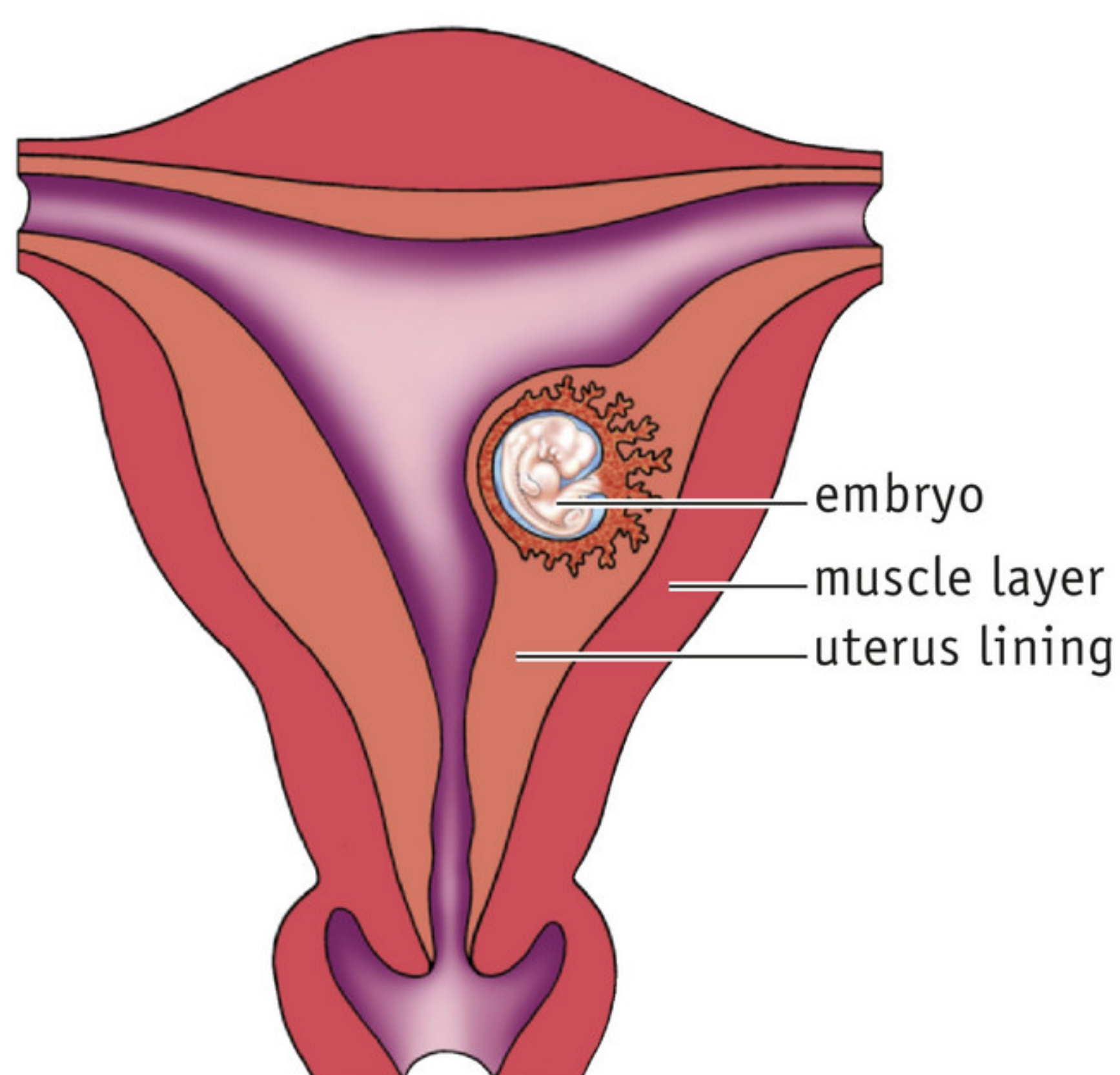
PREGNANCY

The child that develops in the uterus is called the **embryo** for the first few weeks. From the eighth week after fertilisation through to the birth, it is then called the **foetus**. During the first weeks of the pregnancy, the uterus lining provides nutrients for the embryo (see figure 47).

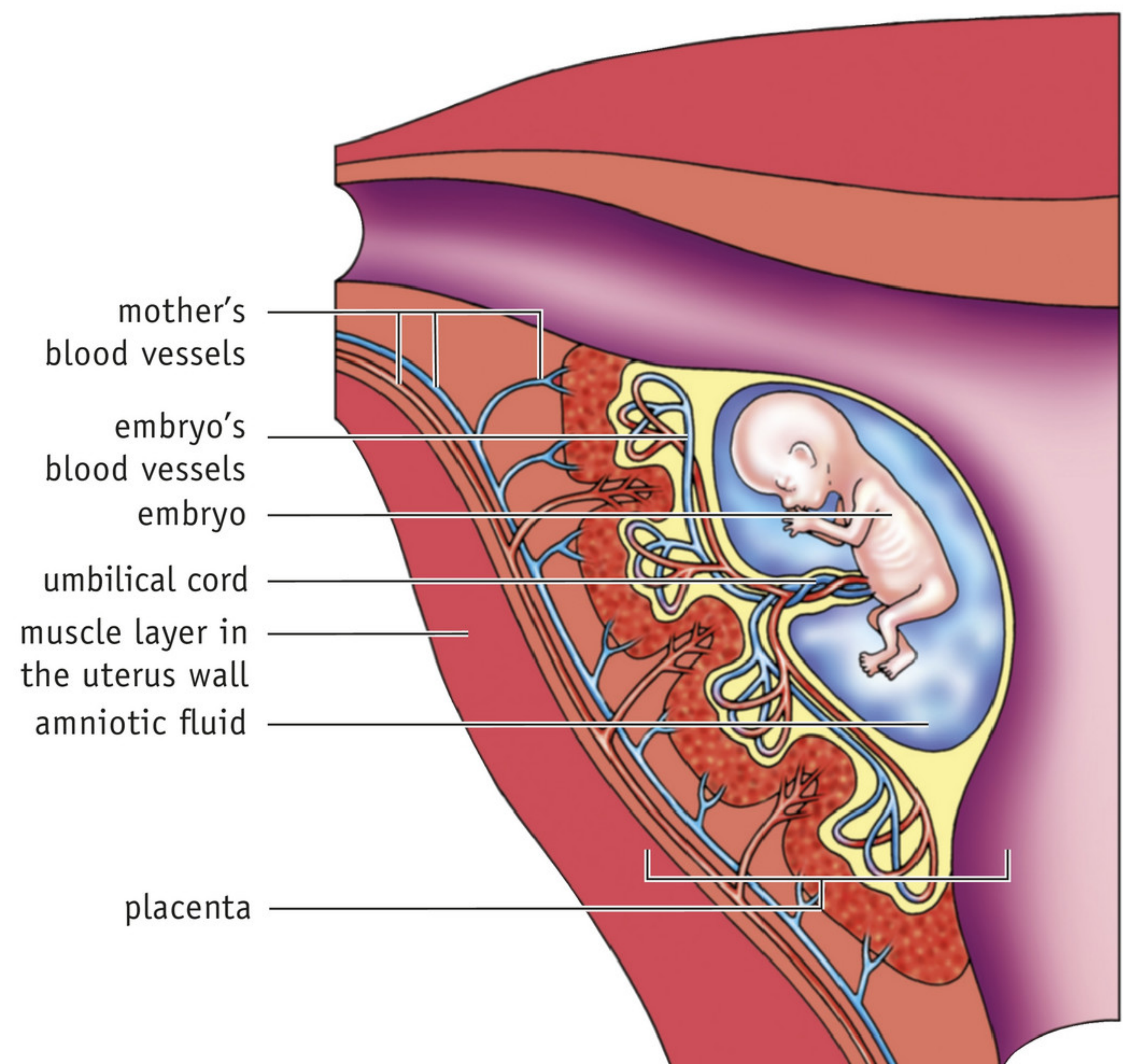
After that, the **placenta** forms (see figure 48). This is a special part of the uterus lining in which blood from the blood vessels of the embryo flows very close to the mother's blood. This allows substances to be exchanged between the blood of the mother and the blood of the embryo. The blood of the mother does *not* flow through the embryo. The mother's blood remains separated from the embryo's blood by thin membranes.

The embryo is joined to the placenta by the **umbilical cord** (see figure 48). Oxygen and nutrients cross from the blood of the mother to the blood of the embryo. Waste products cross from the blood of the embryo back to the blood of the mother.

▼ Fig. 47 Embryo in the uterus lining (diagram).



▼ Fig. 48 Embryo in the womb (diagram).



The embryo is surrounded by two membranes called the **amniotic sac**. Inside the amniotic sac is the **amniotic fluid** (see figure 49). The embryo floats in the amniotic fluid. This protects it against knocks, against dehydration and against temperature changes. On top of that, it makes it easy for the embryo to move.

The mother's body has in the meantime also prepared itself to feed her baby after the birth. During pregnancy, the **mammary glands** in the breasts will have developed. The breasts therefore become enlarged.

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▼ **Fig. 49** Various stages in the development of an unborn child.



1 embryo, aged six weeks



2 fetus, aged eight weeks



3 fetus, aged twelve weeks

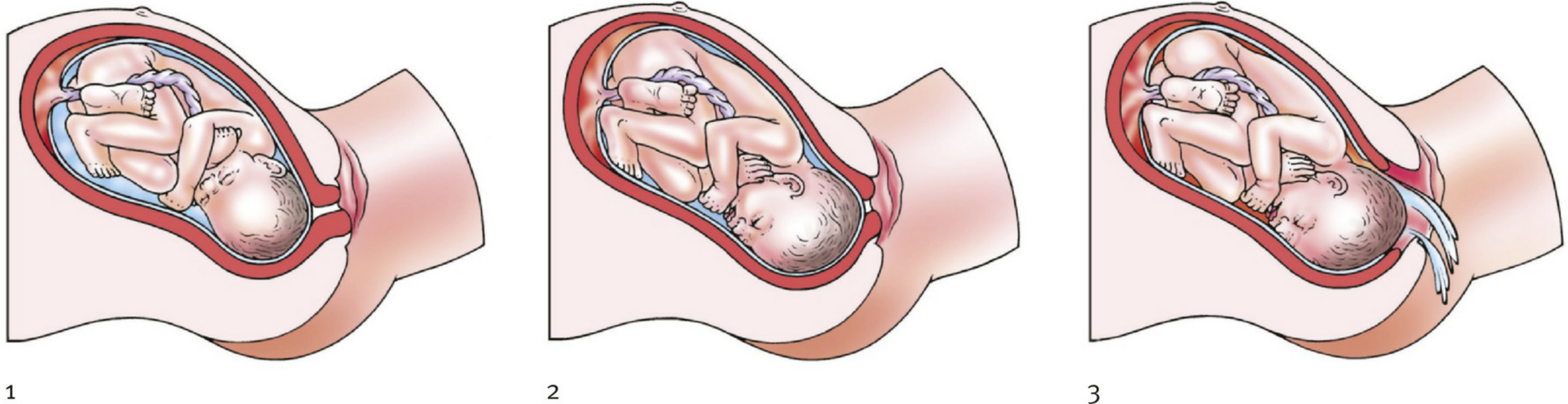


4 fetus, aged five months

THE BIRTH OF A BABY (LABOUR)

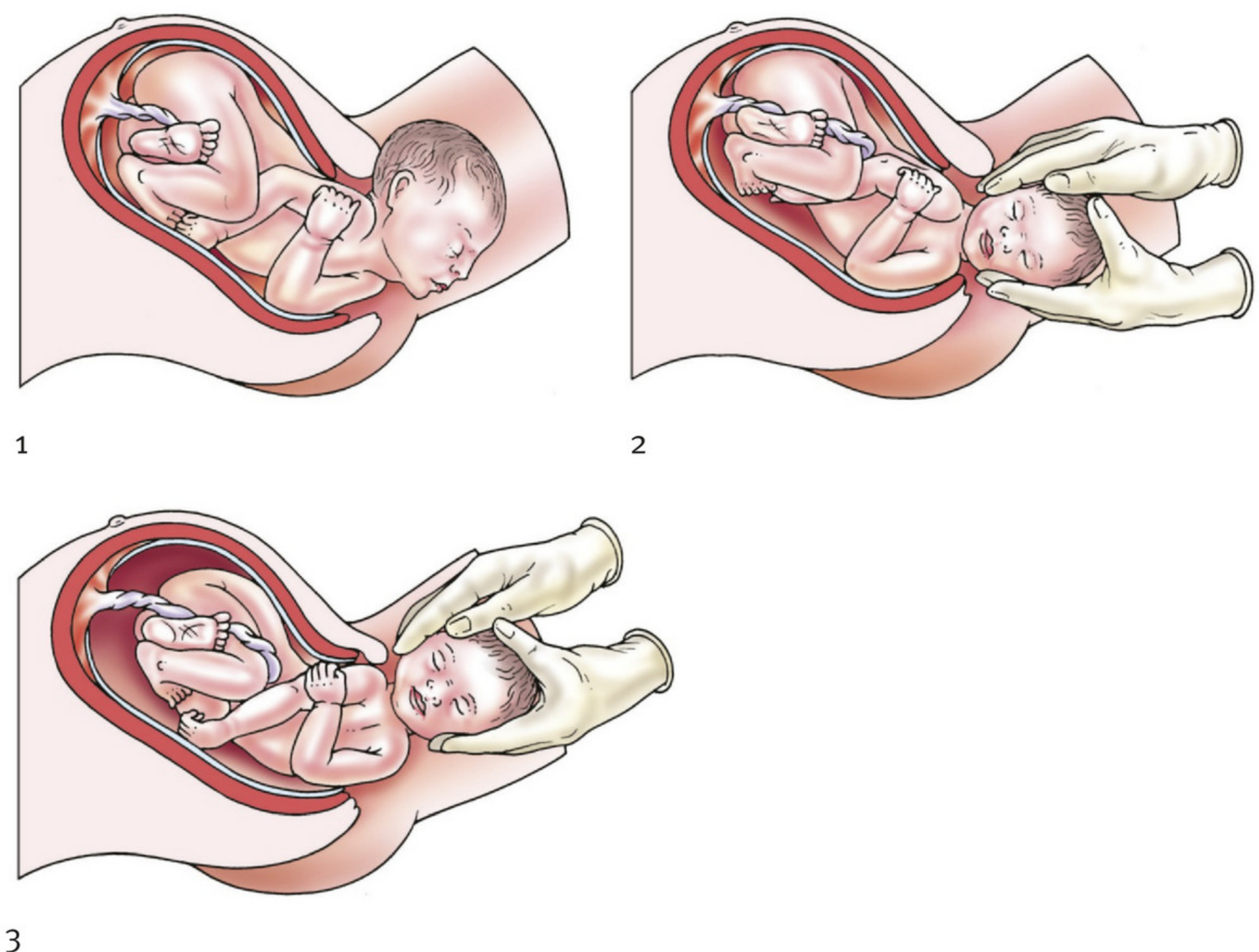
The first sign that **labour** is starting are usually **contractions**. These are contractions of the muscles in the uterus wall, with intervals in between. During the contractions, the cervix (mouth of the uterus) becomes wider (see figure 50). This is called **dilation**. The amniotic sac generally ruptures ('the waters break'), and the amniotic fluid flows out of the vagina. It may take anything up to twenty hours for the dilation to be sufficient for the baby's head to pass through.

▼ Fig. 50 Dilation.



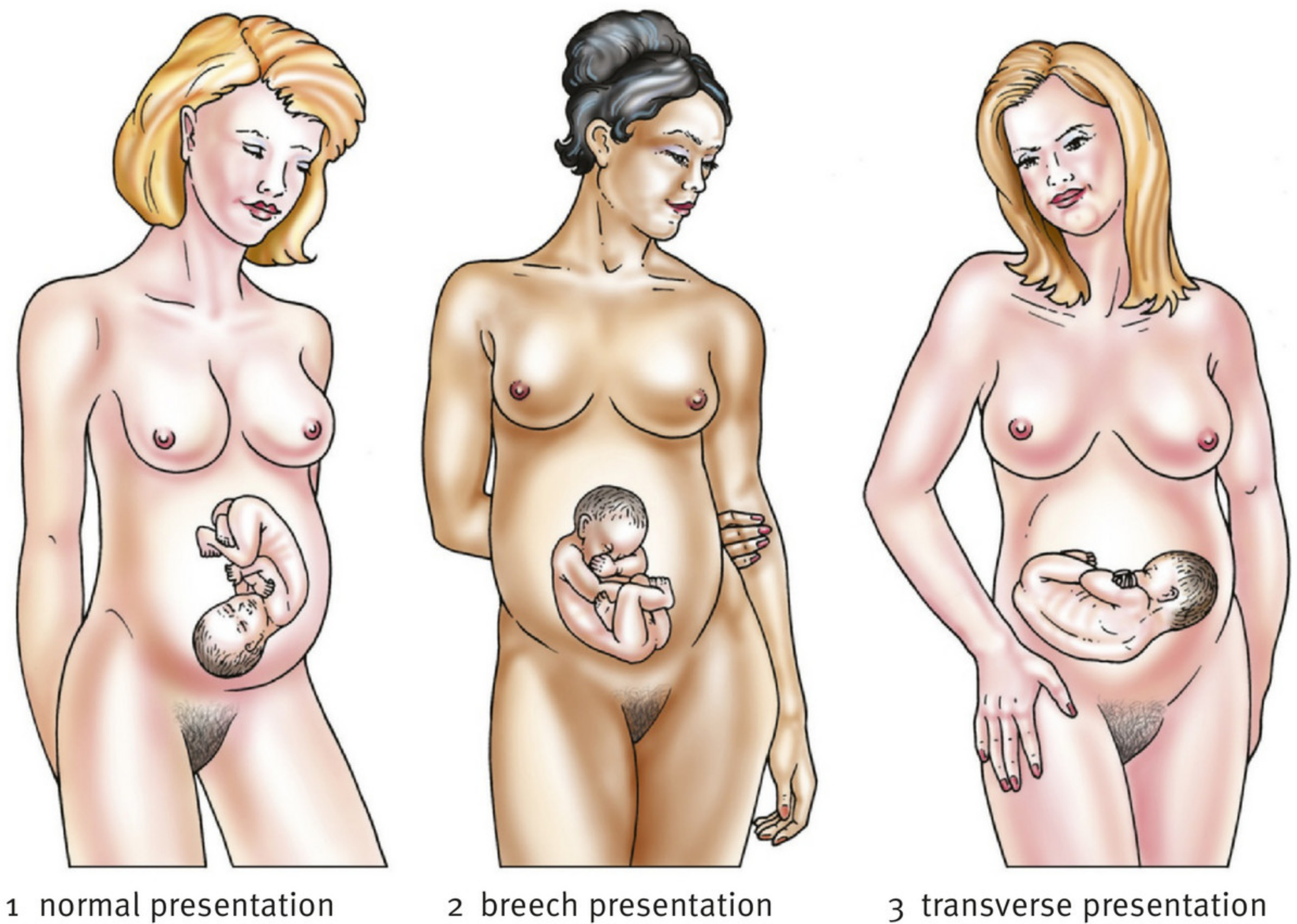
This is then followed by the **delivery** (see figure 51). The contractions become increasingly powerful and the muscles in the abdominal wall start contracting too. These more powerful **expulsion contractions** push the baby out. The delivery may take anything from a few seconds to a couple of hours.

▼ Fig. 51 Delivery.



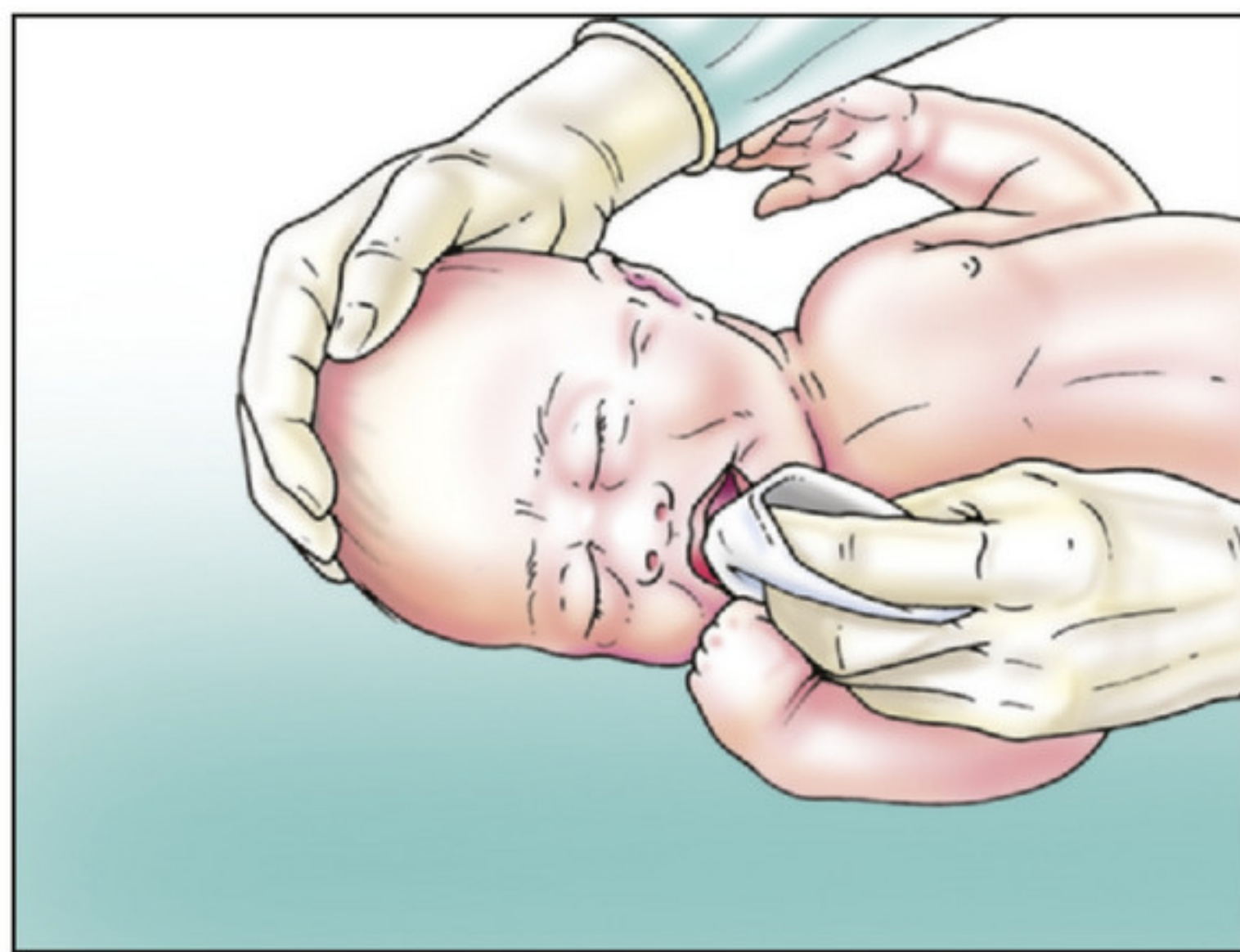
In a normal birth, the head appears first. In a **breech presentation** (see figure 52.2), the rump or a foot will come out first. In a **transverse presentation** (see figure 52.3) the baby cannot be born vaginally and it will be born through a surgical procedure that opens the abdominal wall (**caesarean section**). The child will also often be born by caesarean in a breech presentation. A transverse presentation is rare.

▼ **Fig. 52** Location in the abdomen of the mother.

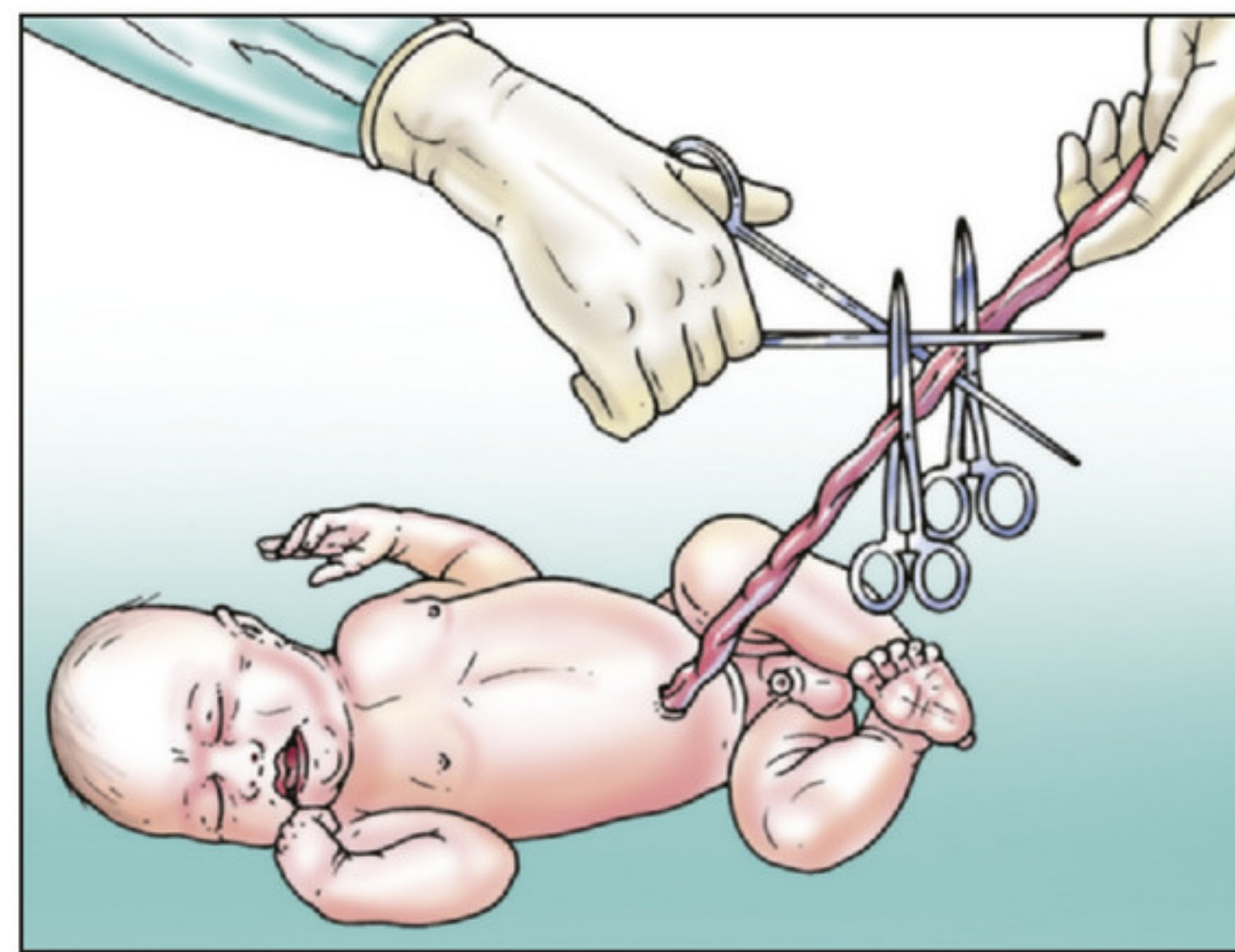


After the birth, residues of mucus are removed from the baby's mouth and airways (see figure 53.1). The umbilical cord is then clamped off and cut (see figure 53.2). The baby will usually start to cry straight away. That's a good sign: it means the child has started breathing properly. The part of the umbilical cord that is attached to the baby dries out over the course of about a week and then falls off. This leaves a kind of scar on the baby's belly, the **navel** (belly button).

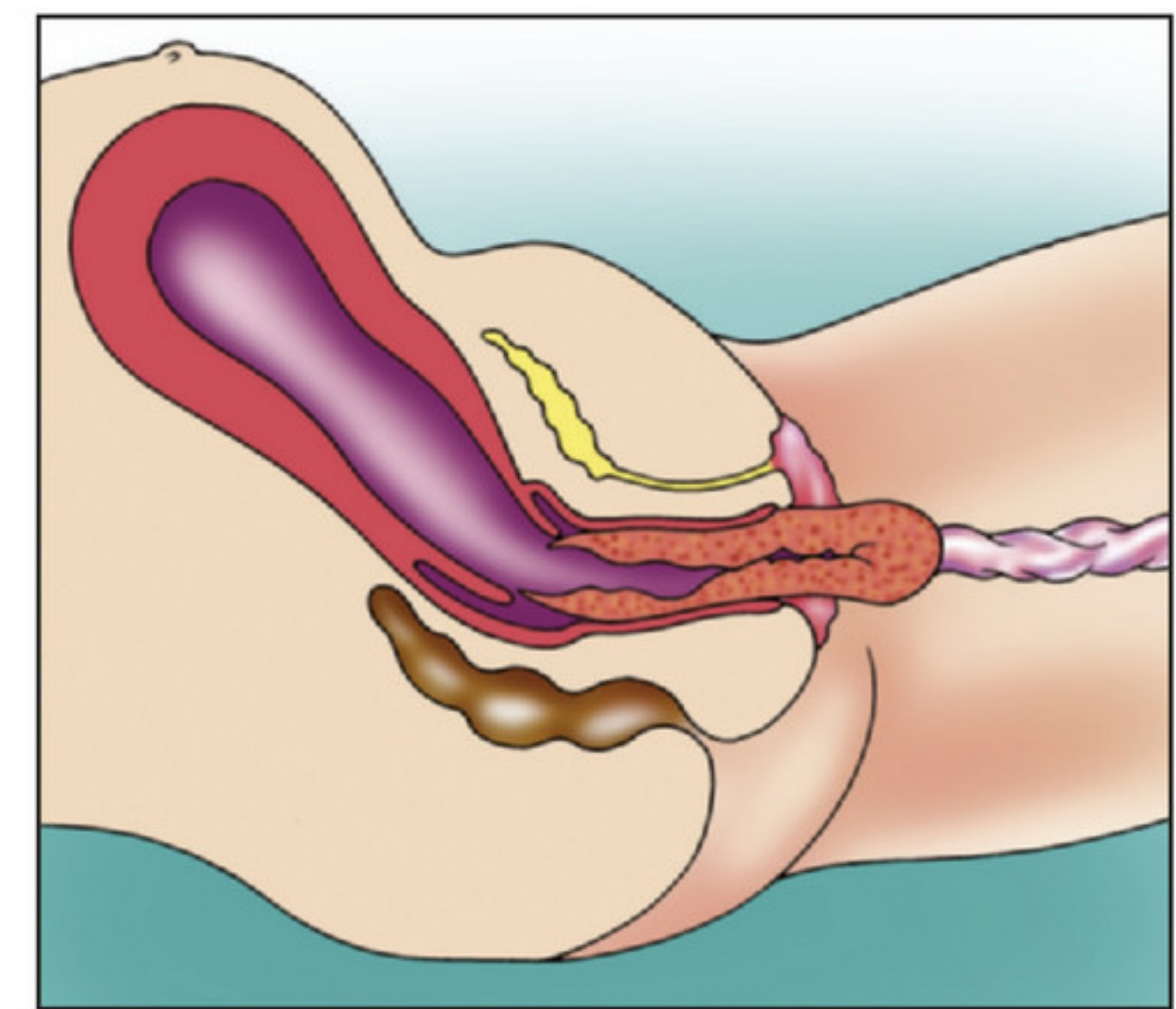
▼ **Fig. 53** After the birth.



1 mucus residues are removed from the baby's mouth



2 the umbilical cord is clamped and cut



3 afterbirth

Labour is not completely finished once the baby has been delivered. Contractions of the uterus wall push out the placenta and the remains of the umbilical cord and the amniotic sac. These are then expelled about a quarter of an hour after the delivery of the baby (see figure 53.3). This is known as the **afterbirth**. The afterbirth can be speeded up by an injection of a hormone. The midwife or obstetrician checks that the whole afterbirth has come out (see figure 54.3).

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▼ Fig. 54

Midwife

Hello, I'm Anne. I work as a midwife and I help women during their pregnancy, labour and the first few days afterwards. In order to give you an impression of my work, I'll tell you quickly about the last birth. I went to see Mrs Williams at two o'clock. She was having strong contractions and the waters had already broken naturally. I watched to see how she was coping with the contractions, how often they were coming and how strong they were. Then I felt to see what position the baby was in, listened to its heart and did an internal examination to assess Mrs Williams's dilation. She was fully dilated (10 cm). I got everything ready and called the maternity care service. When the delivery contractions came, I told Mrs Williams that she should push along with them. After 45 minutes, she had given birth to a lovely son. The father cut the umbilical cord

and I examined the baby: a healthy little boy. Once the afterbirth had been expelled, it was time for the traditional treats. In the meantime, I completed all the forms and kept a close eye on both mother and child. This was a quick birth.

Sometimes it does not go so smoothly. For example, if there is a breech birth or if the baby is distressed or if there is faecal matter in the amniotic fluid. The baby is then usually born in the hospital. For many women, pregnancy is an exciting but nevertheless enjoyable time, despite the fact that they can get all kinds of symptoms because of the pregnancy, and despite the birth being very painful, of course. I find it very satisfying that I am able to do something for these women at such a special time.



1 Anne at work



2 mother with newborn baby



3 afterbirth

8

Sexually transmitted infections

There are some diseases that you can only get through intimate physical contact with an infected person. These diseases are called **sexually transmitted infections (STIs)** or **venereal diseases (VD)**. You do not have to have sexual intercourse to become infected. All kinds of homosexual or heterosexual contact can cause someone to become infected if the contact involves the sexual organs, mouth or anus. But it is a myth that you can get an STI from a dirty toilet or by drinking from someone else’s glass. That is because the pathogens that cause STIs soon die when they are outside the human body.

The commonest STI in the Netherlands is chlamydia (see table 1). AIDS is perhaps the most widely known. The pathogen that causes chlamydia is a bacterium; in AIDS it is a virus. You can learn more about other sexually transmitted infections in extra section 10.

▼ Table 1

STI	Estimated number of new infections per year in the Netherlands
1 Chlamydia	60,000
2 Genital warts	25,000
3 Genital herpes	12,000
4 Gonorrhoea	6,000
5 Hepatitis B	2,000
6 Syphilis	750
7 HIV infection (AIDS)	700
Other STDs	3,000

► Fig. 55



CHLAMYDIA

The bacterium that causes **chlamydia** is mainly found in the urethra and cervix of people aged between 15 and 30. The bacterium doesn't cause any symptoms in two thirds of all infected women and half of all infected men. These people do not notice the infection, but they can still pass chlamydia on to other people with whom they have sexual contact.

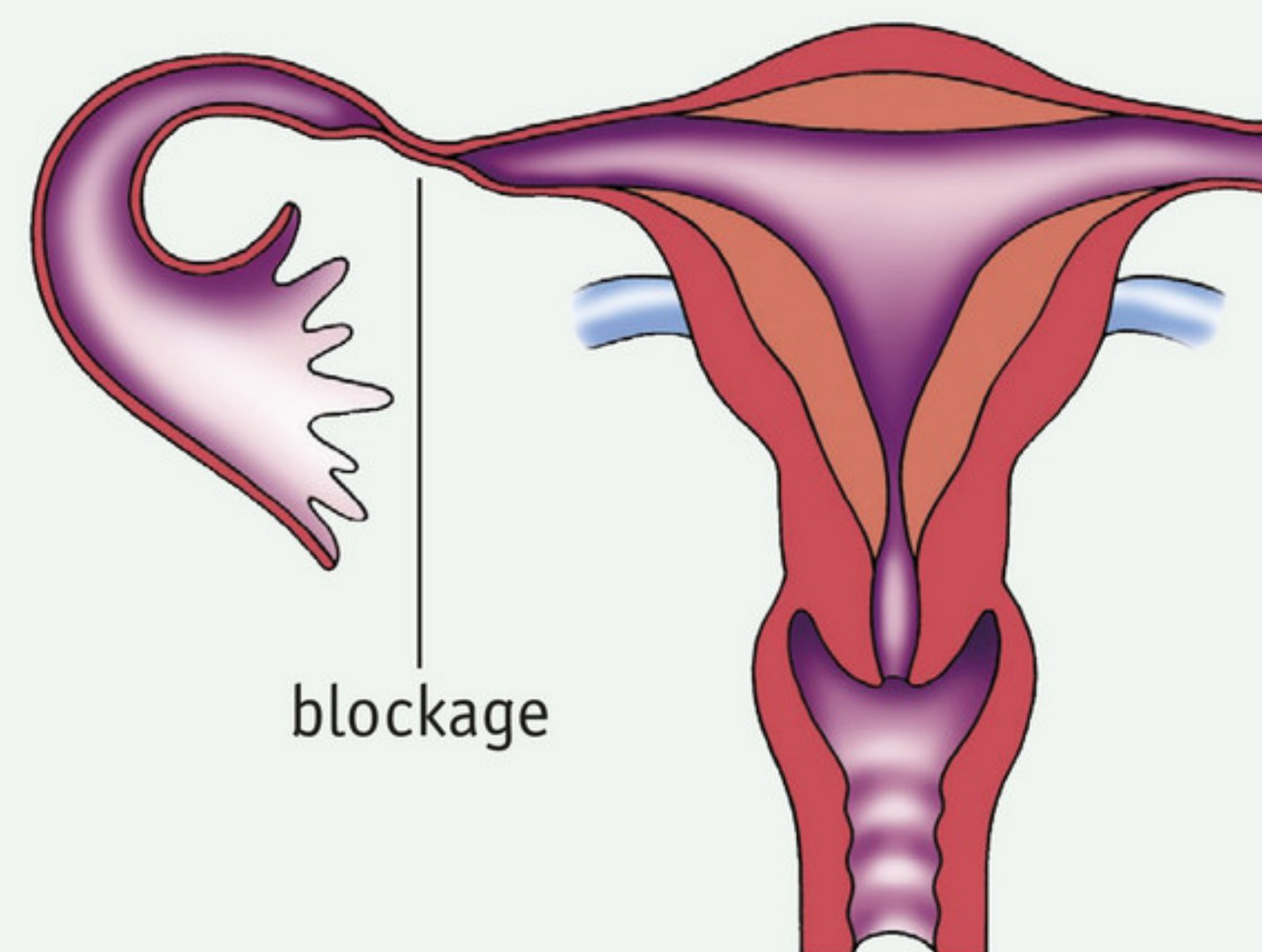
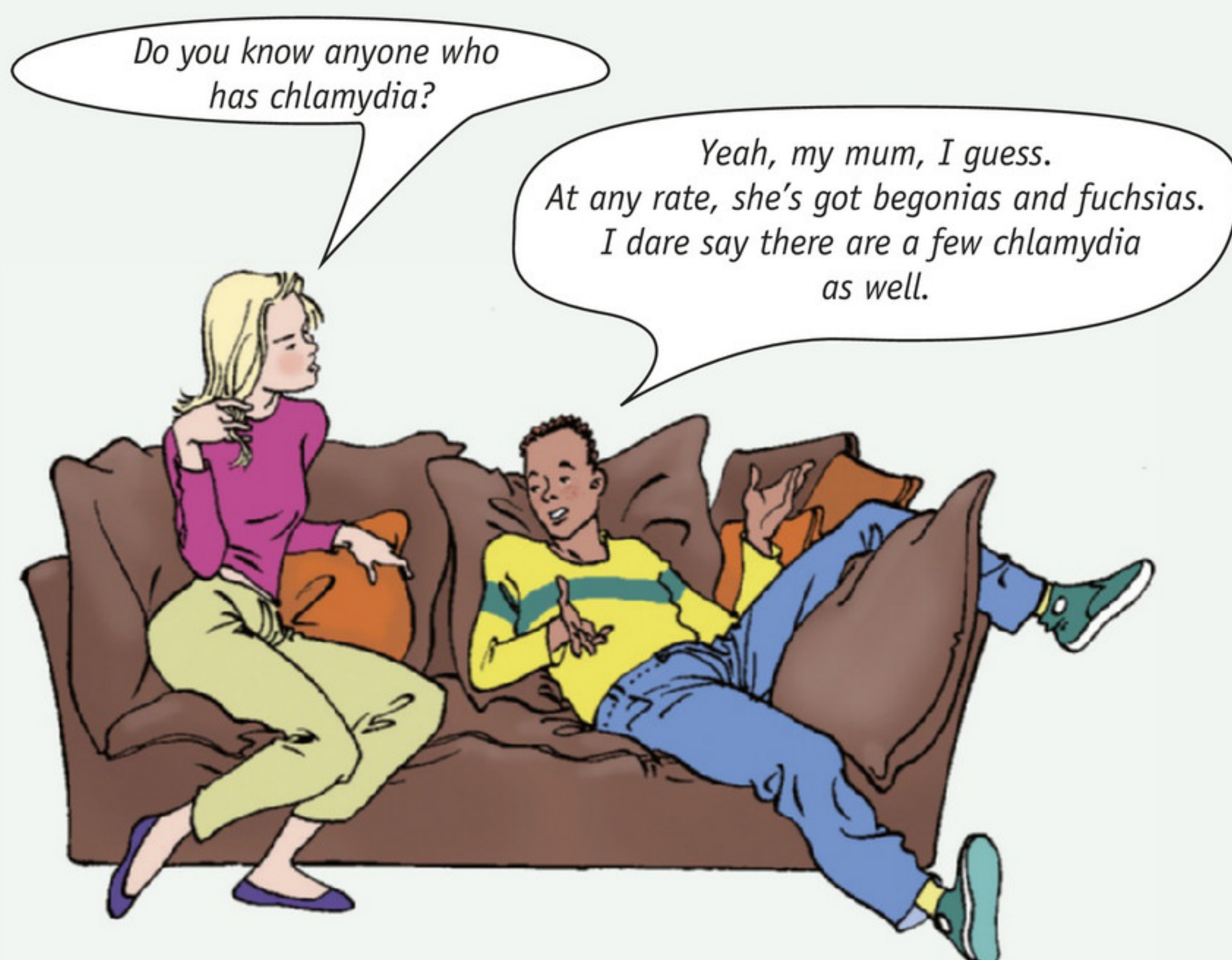
The chlamydia bacterium can cause inflammation in the anus, the cervix or the urethra. In men, the inflammation can lead to the following symptoms: watery secretion from the penis, pain when urinating and pain in the scrotum. In women, the inflammation can lead to pain when urinating, pain during sexual intercourse and pain in the lower abdomen. Some women also have loss of blood from the vagina other than menstruation, and more (or different) vaginal discharge than normal. If chlamydia is not treated in time, the inflammation can spread to the Fallopian tubes or epididymis. The consequences can then be serious (see figure 56). Chlamydia can be treated with an antibiotic.

▼ Fig. 56

Major study of chlamydia

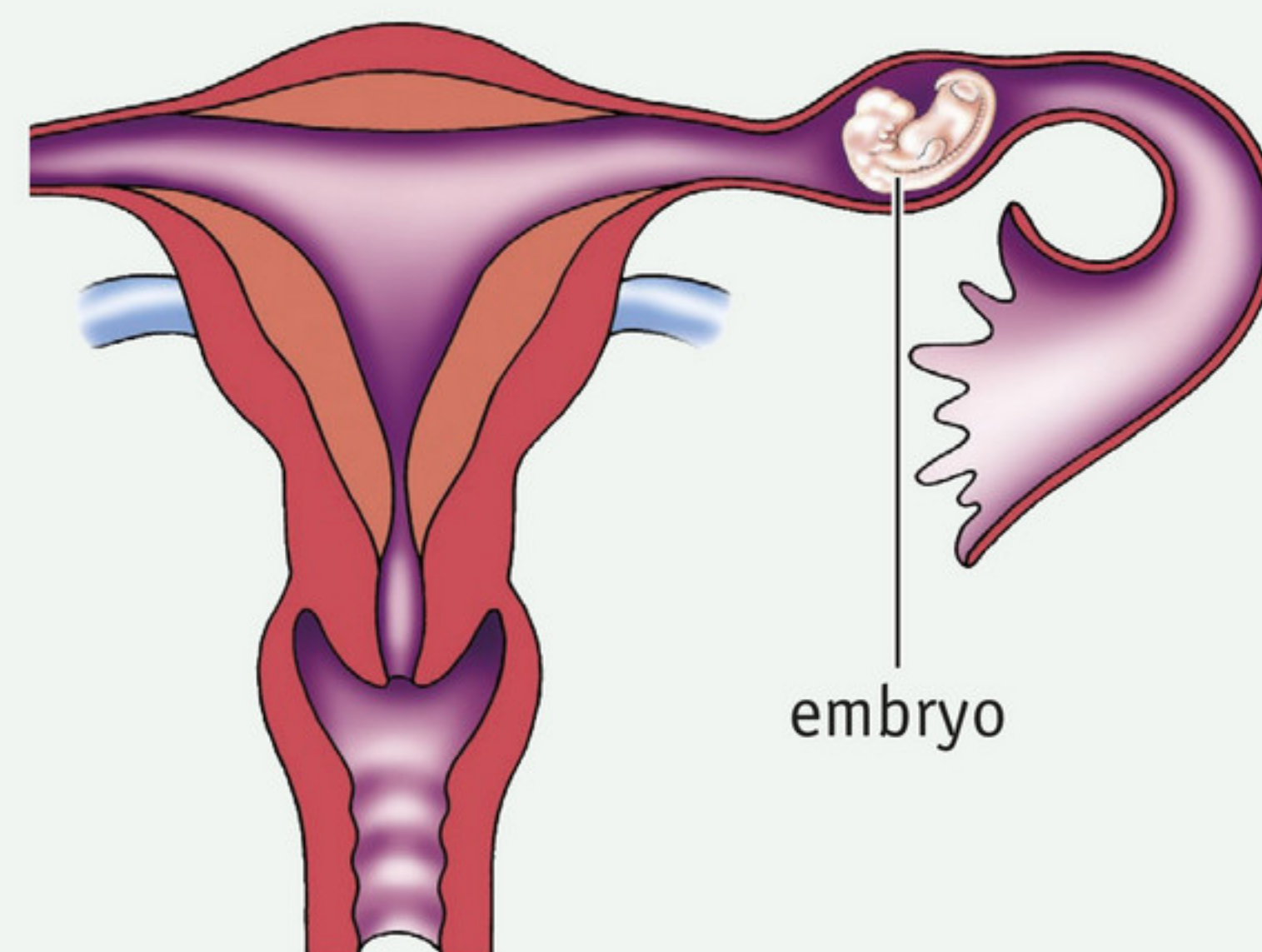
Over three hundred thousand young people will receive a letter inviting them to get themselves tested for chlamydia. The test can be requested via the Internet. Privacy is guaranteed. The benefit of this kind of testing is that it does not involve an uncomfortable internal examination by the GP. Men send a urine sample to the laboratory and women send a smear sample that they can take themselves. You can also get the test results back via the Internet. Some younger people are not sexually active or already have the same partner for some time. They are not at risk of infection, so they do not need to take part in the study.

The figure shows some of the consequences chlamydia can have for a woman if left untreated.



1 infertility

Scar tissue can form in a Fallopian tube after a chlamydia infection. This blocks off the tube. This can make a woman infertile.



2 ectopic pregnancy (outside the uterus)

A fertilised egg cell can get stuck where the chlamydia infection is. This may mean that the embryo starts developing outside the uterus: an extrauterine or ectopic pregnancy.

AIDS

When someone has **AIDS**, their immune system is affected. That makes this person susceptible to all kinds of diseases such as intestinal inflammation, pneumonia or skin cancer. Healthy people can fight off these infections. AIDS patients can suffer from many different diseases, sometimes several diseases at the same time. So AIDS does not have any specific symptoms.

AIDS is caused by the AIDS virus, which is also called **HIV** (Human Immunodeficiency Virus). The HIV virus keeps on changing slightly. Someone can be infected without having any symptoms. That period can last for a few months, but sometimes more than ten years. A special test can show whether a person is infected with the AIDS virus. If a healthy person is shown to have the virus, that person is said to be **seropositive**. Someone who is seropositive should start taking **HIV inhibitors** as soon as possible. The later they start taking HIV inhibitors, the greater the likelihood that they will get full-blown AIDS. AIDS can be fatal. HIV inhibitors are certain combinations of medicines that prevent the HIV virus from multiplying in the body. It is not possible for someone to be cured of a HIV infection, so they have to take HIV inhibitors at specific times for the rest of their life. HIV inhibitors can have side effects such as nausea. Only a small proportion of the world's population have access to these HIV inhibitors (see figure 57).

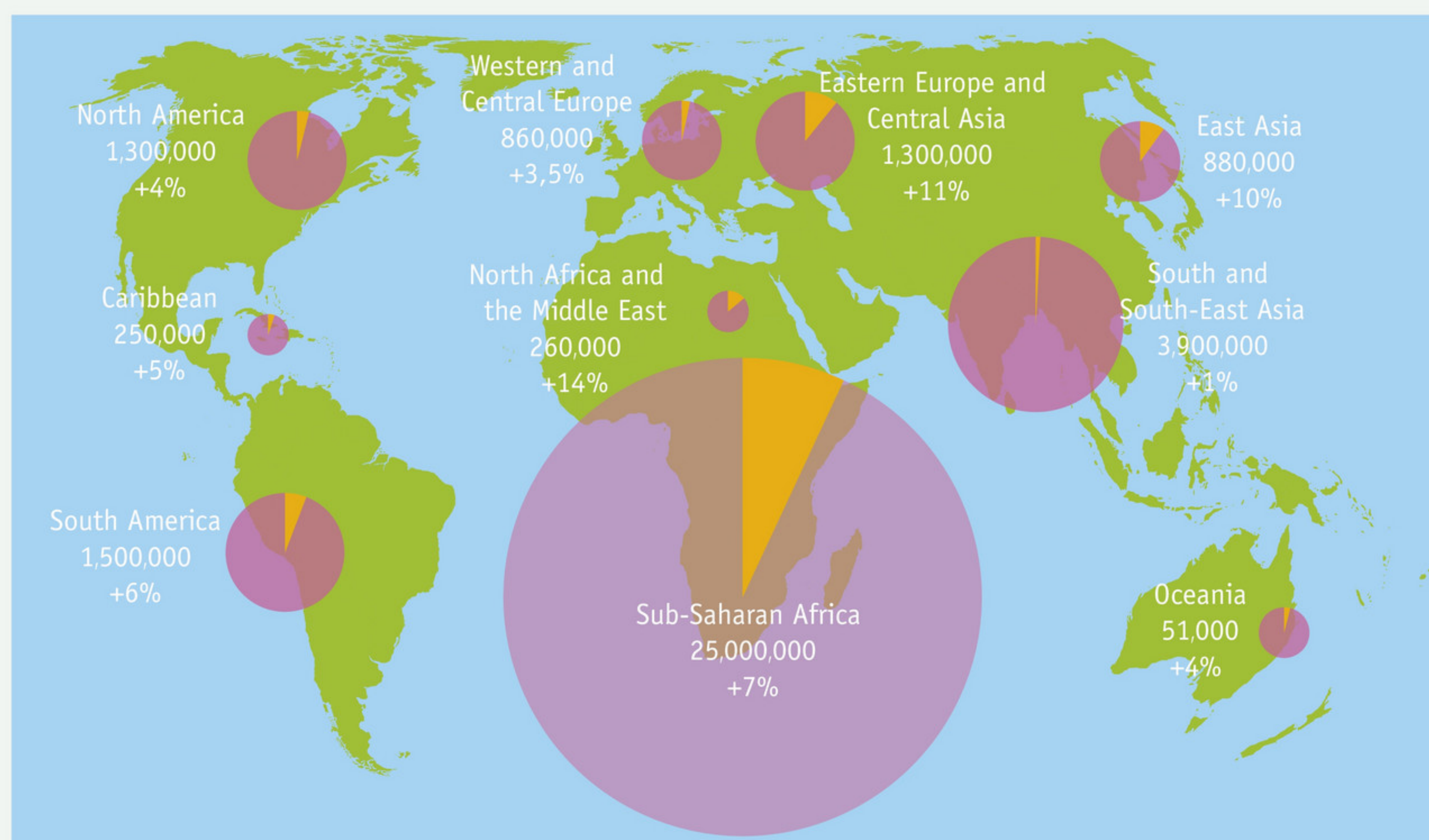
▼ Fig. 57

AIDS worldwide

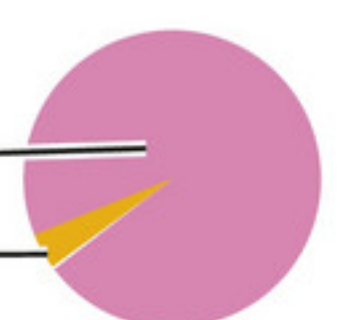
AMSTERDAM – In 2012, 2.3 million people became infected with the AIDS virus (HIV), 1.6 million of them in sub-Saharan Africa. In that year, 1.6 million people died of AIDS. These figures were published by UNAids, the United Nations' AIDS programme, and by the World

Health Organization (WHO). Central and southern Africa above all are affected.

In 2012, the number of people with AIDS infections was estimated at 35.3 million. Only 10 million of those have access to HIV inhibitors.



Legend:
cases of HIV and AIDS
increase in 2012



The AIDS virus can get inside your body via an infected person's blood, semen, vaginal fluid, pre-ejaculation fluid or breast milk. Most infections are the result of unsafe sex (for example sexual intercourse without a condom) or from drugs users sharing needles. The disease cannot be passed on by sneezing, coughing, kissing or using someone else's cutlery. So you can have normal contact with AIDS patients or seropositive people without running any risks.

Many young people still have unsafe sex and get an STI as a result (see figure 58). With some STIs such as chlamydia and HIV, you can become infected without noticing it. You can have an **STI test** to find out whether you are infected.

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▼ Fig. 58

Young people still not safe enough in sex

A quarter of young people still do not use condoms the first time they have sex. Particularly among people who start having sex at a young age, the percentage who do so unprotected is high. Over half of young Dutch people who are in a relationship are having sex without a condom three months later.

That is the result of a study by Rutgers Nisso Groep. The main reasons given for this are that they trust

each other and that lovemaking with a condom is less pleasant.

The safest way, however, is that both partners should have an STI test at the start of a new relationship. And until the result is known, they should use a condom during sex. If the result of the STI test is favourable for both partners three months later, they can have sex without condoms.



9 Other methods of birth control

In basics 6, you learned about two unreliable methods and two reliable methods of contraception. There are also other methods of avoiding pregnancies.

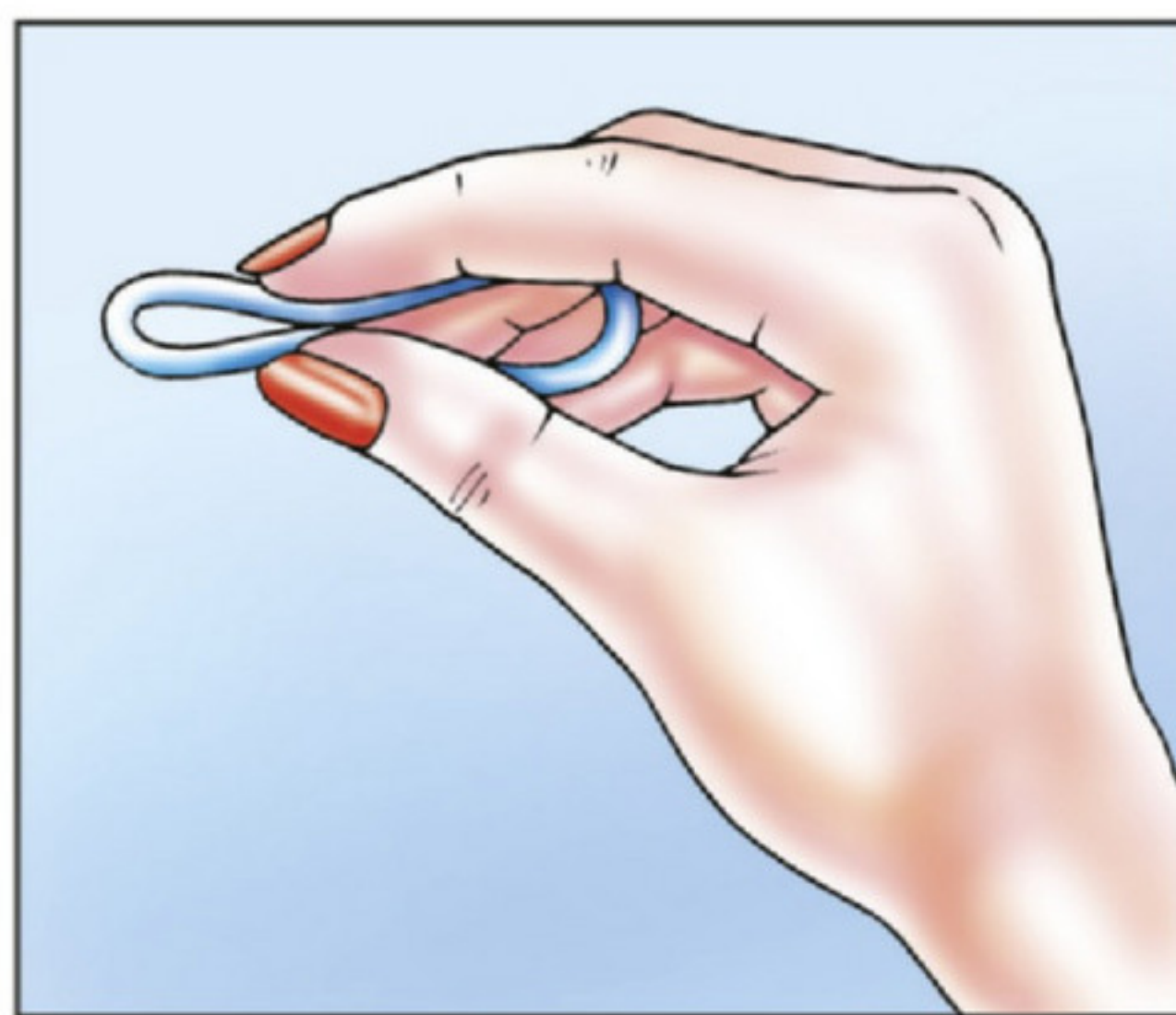
▼ Fig. 59 NuvaRing.



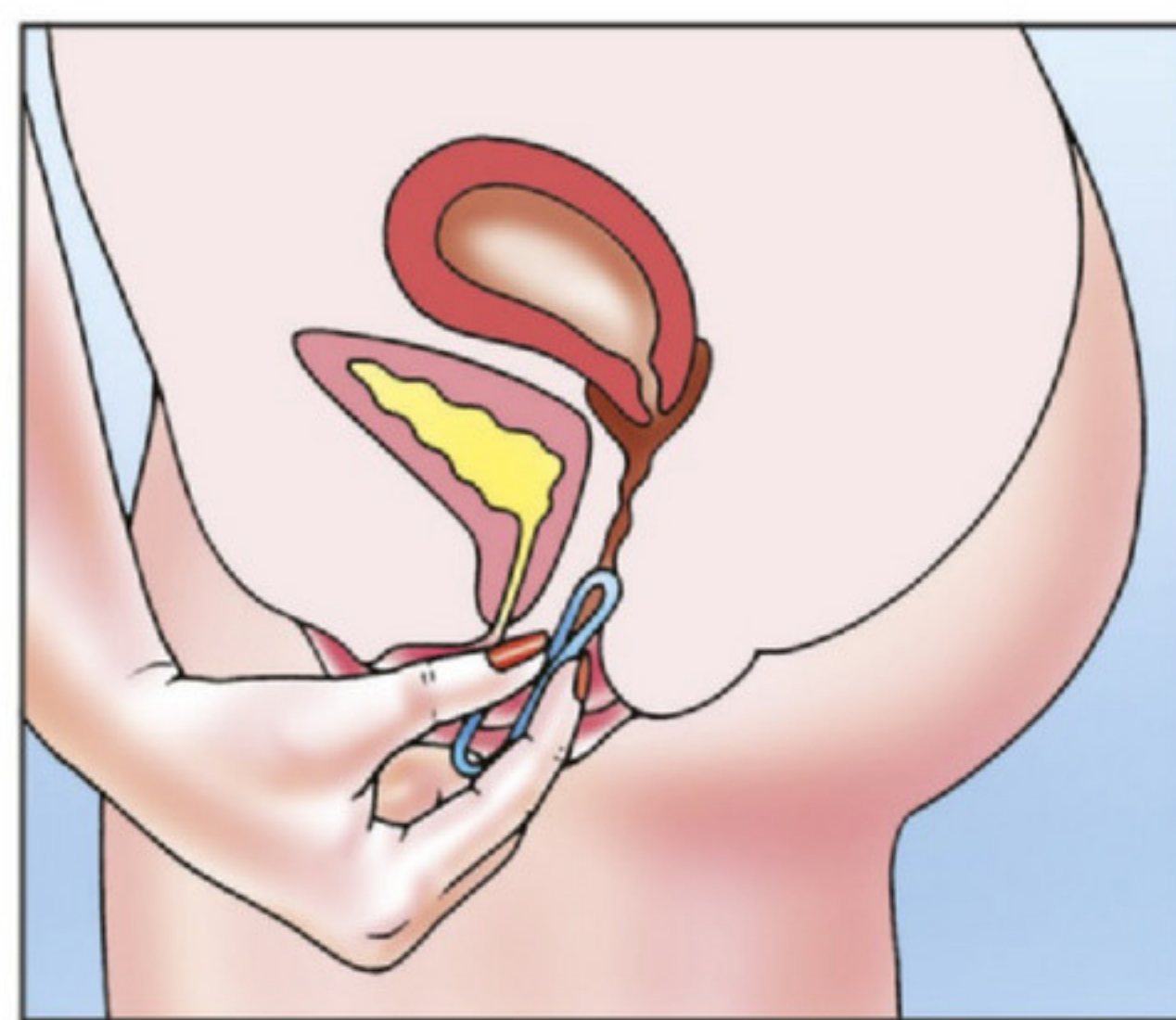
The **NuvaRing** is a fairly new contraceptive device (see figure 59). The NuvaRing is a plastic ring that contains the same hormones as the pill. The woman inserts the NuvaRing in her vagina herself (see figure 60). The woman keeps the ring in the vagina the whole time for three weeks, followed by one week without. The amounts of hormones are lower than those in the pill, so certain side effects are less strong. There is a very small risk of thrombosis when using the NuvaRing, but the pill has that risk too. The NuvaRing is an approved contraceptive device in the Netherlands (2014).

There are other contraceptive devices that contain the same hormones as the pill. The **contraceptive injection** (see figure 61) involves a woman being injected every three months with a hormone that inhibits ovulation. One of the side effects is that menstruation is lighter and may stop altogether. For some women, it can take two years for menstruations to return after they stop having the contraceptive injection. A **contraceptive patch** (see figure 62) is worn on the skin for three weeks and replaced every week. Then there is a week without the patch.

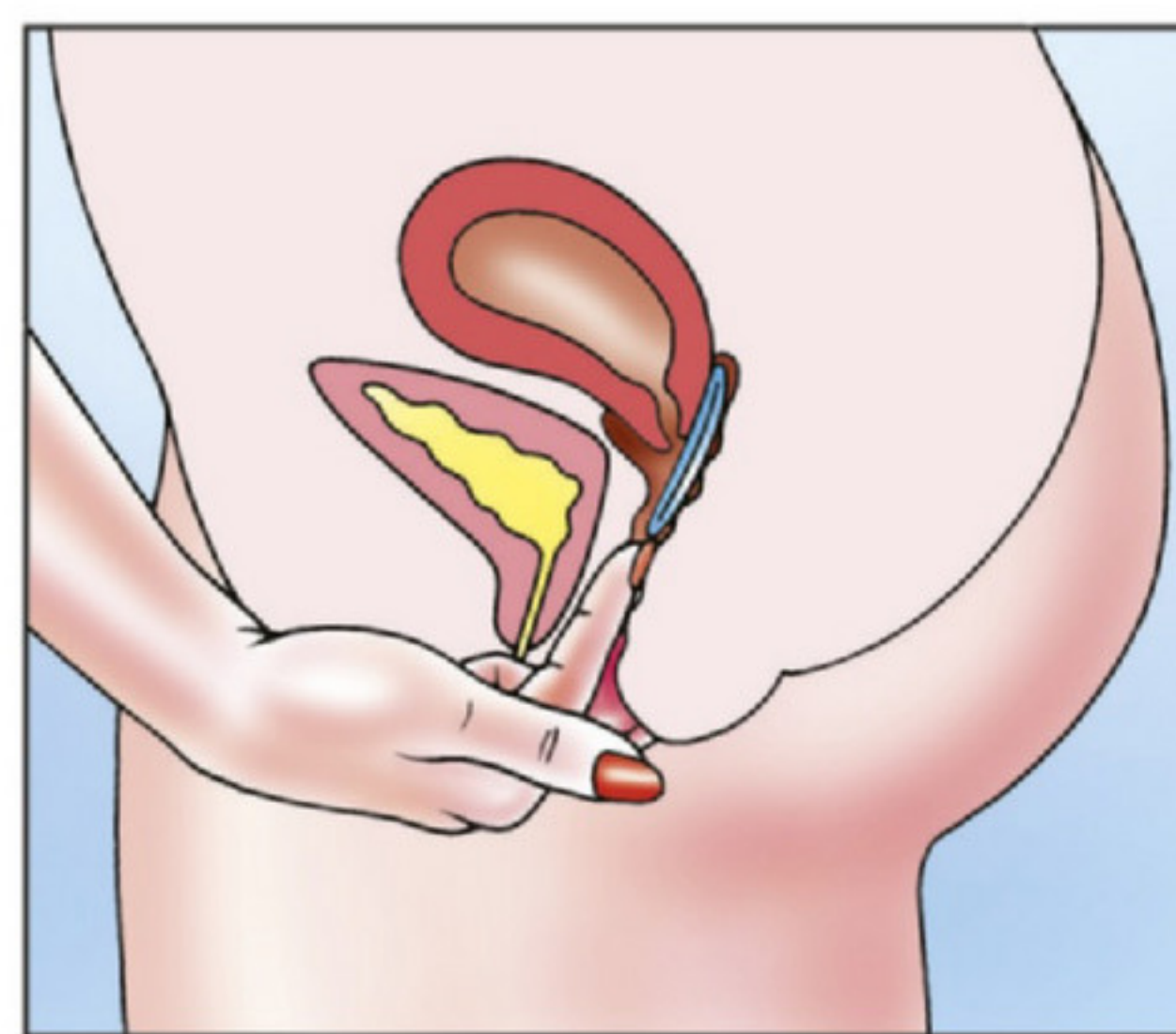
▼ Fig. 60 Inserting the NuvaRing.



1 squeeze the ring between thumb and forefinger



2 insert the folded ring gently into the vagina



3 push the ring into the vagina as far as possible, so that the ring is positioned comfortably

▼ Fig. 61 Contraceptive injection.



▼ Fig. 62 Contraceptive patch.

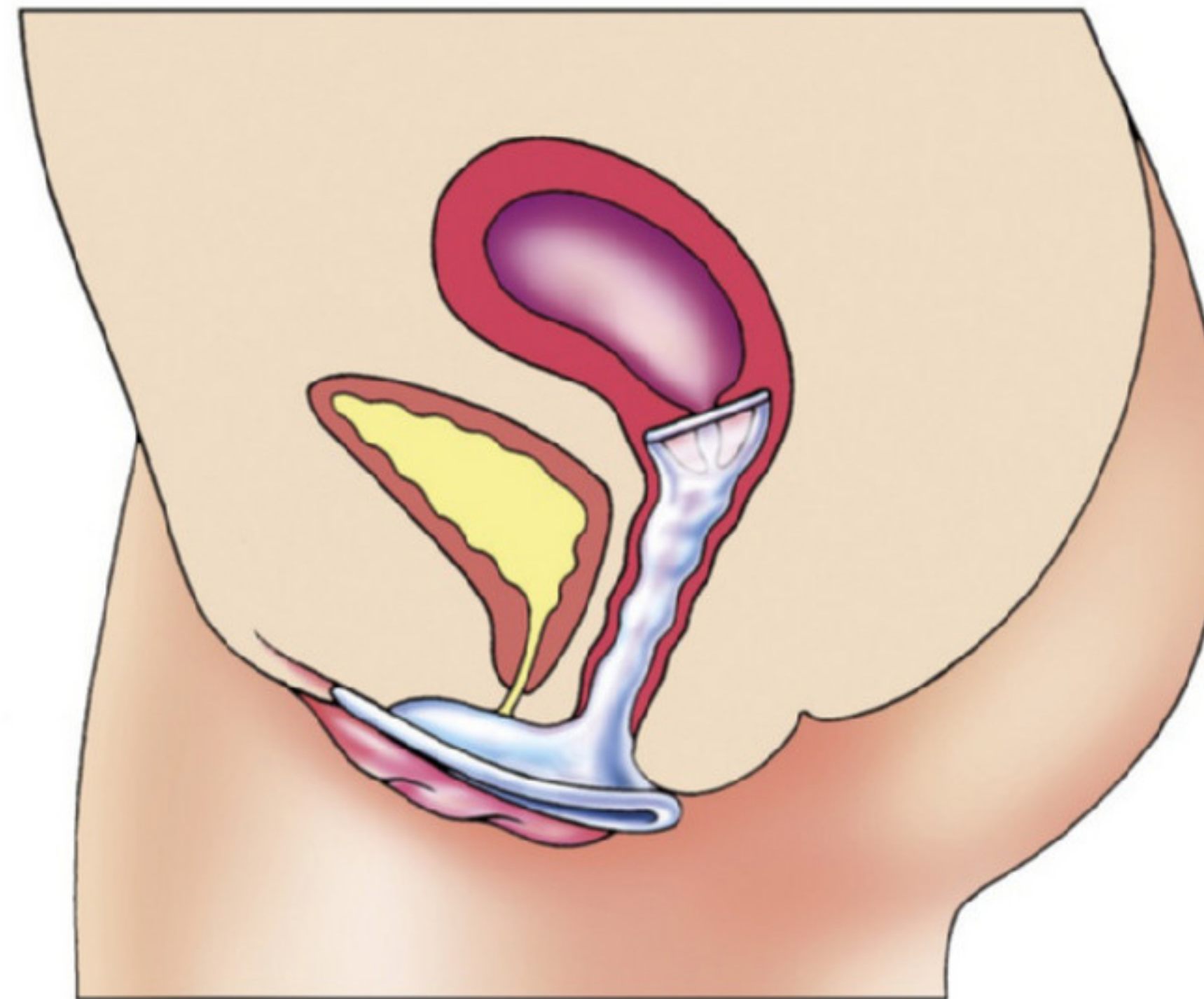


The **female condom** is a special kind of condom that is inserted in the vagina (see figure 64). It can be inserted several hours before sex so there is no need to interrupt the sex. Each female condom must only be used once.

▼ **Fig. 63** Female condom.



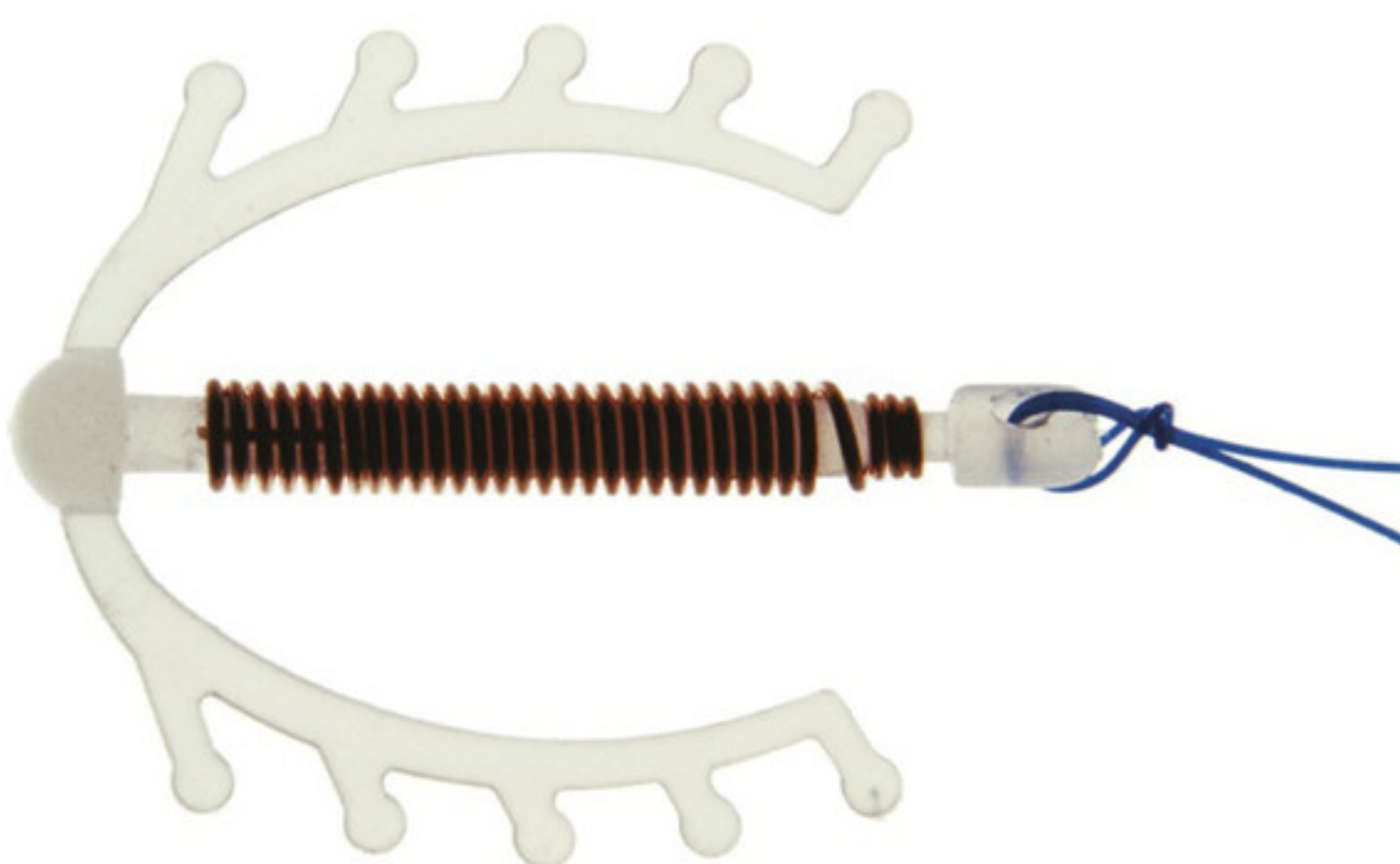
▼ **Fig. 64** A female condom, inserted into the vagina.



▼ **Fig. 65** IUDs.



1 hormonal coil



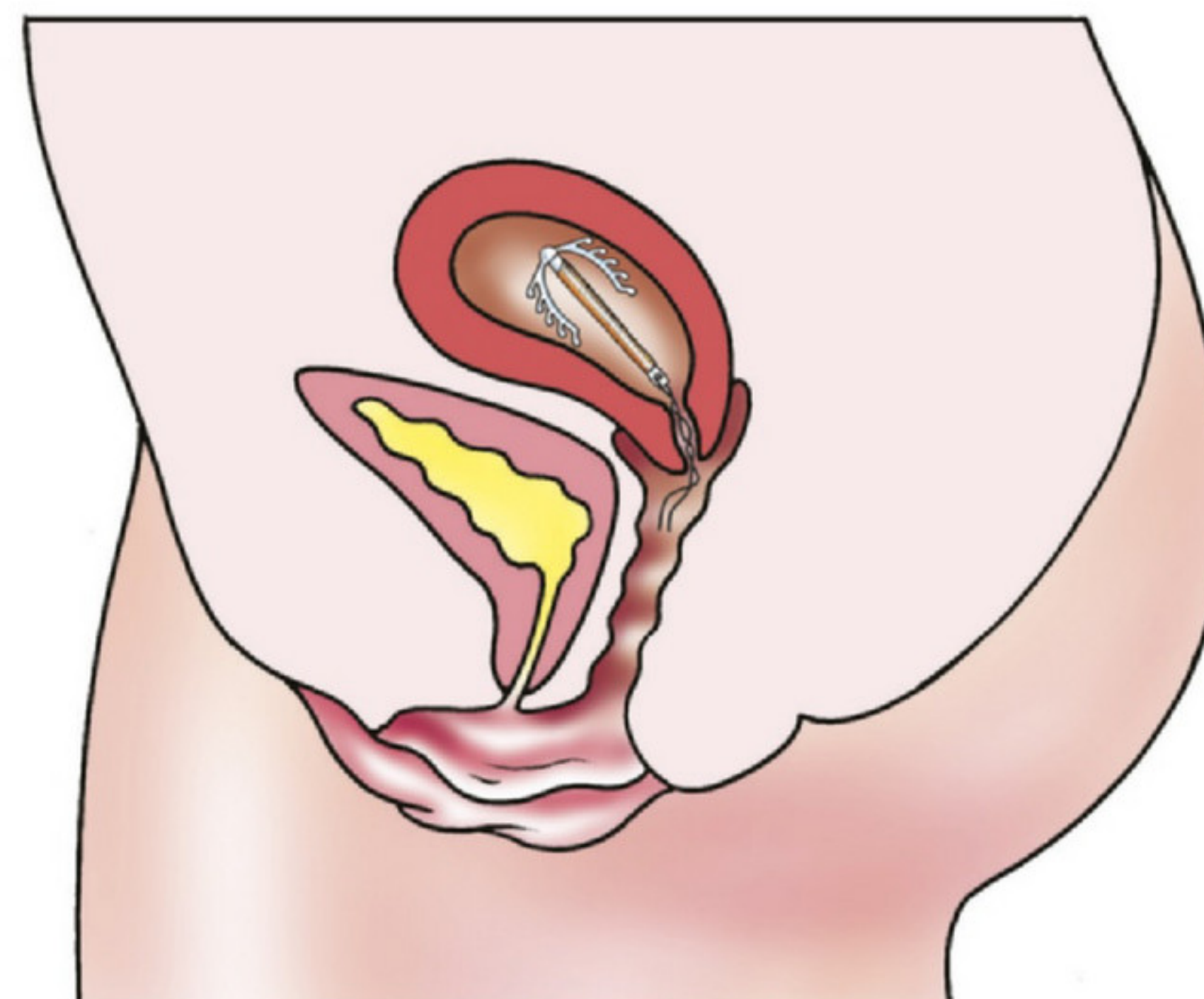
2 copper coil

The **coil** or **intrauterine device (IUD)** (see figure 65) is inserted in the uterus by a doctor (see figure 66). There are two kinds of coil. A **hormonal coil** (see figure 65.1) releases small amounts of hormone every day. The effect of the hormones is to inhibit fertilisation and implantation. The hormonal coil reduces the loss of blood during menstruation. So women also have fewer menstrual problems. The effect of the hormonal coil wears off after five years and it has to be replaced.

The **copper coil** is wrapped in a copper thread (see figure 65.2). A copper coil can remain in the uterus for a long time; ten years is no exception. In the uterus, the copper coil causes a reaction that affects sperm cells and inhibits implantation.

A side effect of a coil is that menstruation can be somewhat heavier to start with and can be accompanied by stomach cramps. Coils are easy to use because there is nothing you might forget.

▼ **Fig. 66** A coil inserted into the uterus.



Sterilisation is a minor operation that makes a man or woman infertile. In men, both sperm ducts are sealed off (see figure 67.1). The production of sperm cells continues as normal. There is no change either in the amount of fluid released in an ejaculation. But the sperm cells that are produced can no longer leave the body. They are broken down in the epididymis and the sperm duct.

In women, the Fallopian tubes are sealed off, so that the ova can no longer come into contact with sperm cells (see figure 67.2).

▼ Fig. 67 Sterilisation (diagram).

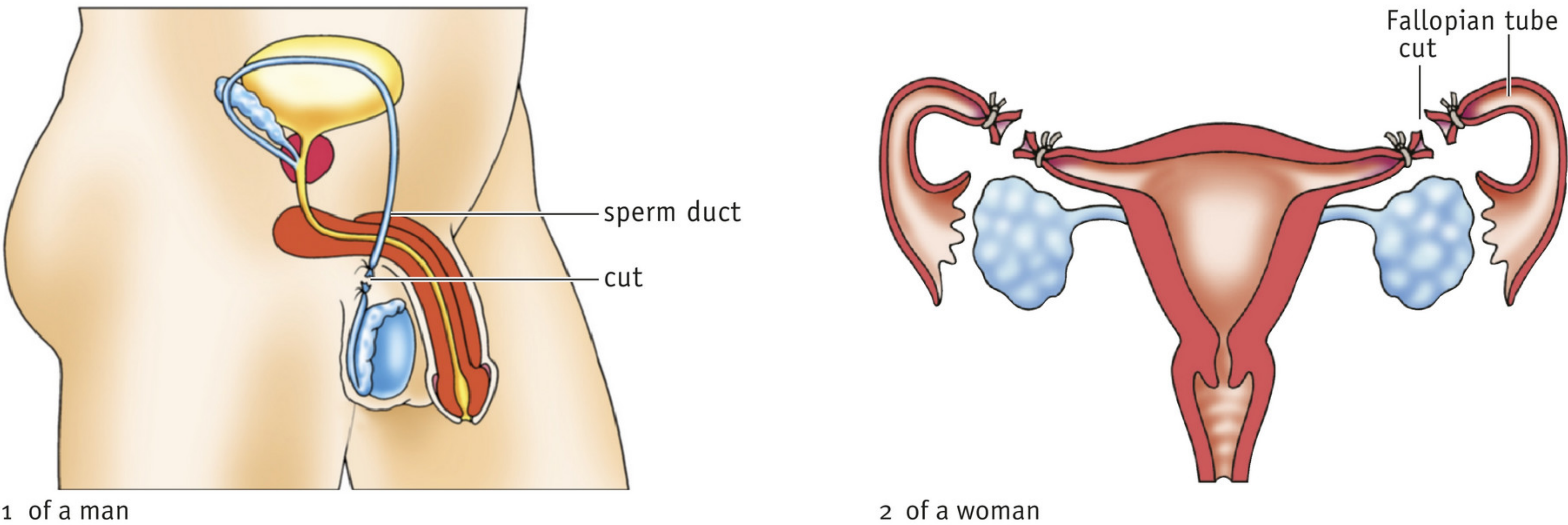


Figure 68 shows an investigation into the reliability of different methods of contraception.

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▼ Fig. 68

INVESTIGATION RELIABILITY OF NINE METHODS OF CONTRACEPTION			
Problem definition	Which methods of contraception are reliable?		
Experiment	This study counted the number of unintended pregnancies in one year among one hundred sexually active women of childbearing age using a particular method of birth control. Nine different methods of contraception were tested. The results are shown using the Pearl index (the pregnancy rate). The 'perfect use' Pearl index shows the percentage of pregnancies if the method in question is used perfectly. In practice, however, errors are sometimes made in using them, which gives a percentage for 'actual use'.		
Results		Perfect use Pearl index	Actual use Pearl index
	1 Condom	2	5 to 12
	2 The pill	2 to 3	5
	3 Withdrawal method	1	12 to 38
	4 Rhythm method	3.3	6 to 49
	5 NuvaRing	0.4	0.5 to 2
	6 Contraceptive injection	0.1	0.5
	7 Female condom	2.6	3 to 5
	8 IUD	0.2	1 to 3
	9 Sterilisation	0.25	0.5

10 Other sexually transmitted infections

In the basics, you learned about two sexually transmitted infections: chlamydia and AIDS. In table 1, you saw that there were other STIs too. In this extra section, you will find out about genital warts, genital herpes and gonorrhoea.

GENITAL WARTS

Genital warts (see figure 69) are benign skin abnormalities on the genitalia and around the anus. The warts can also develop in the vagina or anus. Genital warts are the second most common STI after chlamydia. The warts do not affect your health, but they can be very annoying. They are passed on by certain variants of the human papilloma virus (HPV). Like normal warts on your hands and feet, genital warts are infectious. Genital warts are usually passed on through sexual contact. An infection can also take place through sharing a hand towel or flannel. You can treat genital warts yourself by regularly applying a lotion or a cream. The warts can also be treated by a doctor, who can heat them, freeze them or surgically remove them. Genital warts can spread, which is why it is important to treat them quickly.

HERPES

Genital herpes (see figure 70) is an STI that is normally caused by the herpes simplex virus (type 2). The virus can cause an infection. Usually it is the skin on or around the penis, the labia, the vaginal entrance or the anus that becomes infected. Red spots develop there that change into blisters and sores or small wounds after about 36 hours. You get itching and a burning sensation. There might be pain when urinating or vaginal discharge. The blisters and sores dry up and heal after a few weeks, usually without leaving any scars. After one attack, the virus can multiply again and cause a new attack. There is no medicine for eliminating this virus. However, there are medicines that can stop the virus spreading and reduce the number of attacks. The treatment usually consists of taking tablets.

▼ **Fig. 69** Genital warts.



▼ **Fig. 70** Genital herpes.



▼ **Fig. 71** Herpes labialis.



Another well-known herpes infection is **herpes labialis** or **cold sores** (see figure 71). This infection is normally caused by the herpes simplex virus (type 1).

GONORRHOEA (CLAP)

Gonorrhoea (see figure 72) is an STI that is caused by a bacterium. The bacterium can lead to an infection of the urethra, the anus or the cervix. The throat can also become infected. This usually happens when the mouth comes into contact with sex organs (oral sex).

Women often have no symptoms but they sometimes have a rancid, yellowish green vaginal discharge that usually smells unpleasant. An infection can also cause pain when urinating. If the infection is not treated, it can spread upwards to the Fallopian tubes, leading to inflammation there. If an inflammation of the Fallopian tubes is not treated in time, it can result in scars in the tubes. These scars can block the tube and ultimately result in infertility. In men, yellowish-green pus or transparent mucus may come from the urethra. This effect is the reason why gonorrhoea is also known as **druiper** ('dripper') in Dutch. If the infection is not treated in time, it can spread to the prostate gland or epididymis, causing a fever and pain when urinating. Gonorrhoea is treated with antibiotics.

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▼ **Fig. 72** First signs of gonorrhoea in a man.



Summary

OBJECTIVE 1

You should be able to name the primary and secondary sexual characteristics. You should also be able to say what physical, emotional and social changes take place in puberty.

- Sexual characteristics: characteristics that let us recognise someone's gender (male or female).
- The primary sexual characteristics are present from birth.
 - In boys, they include the scrotum and penis.
 - In girls, they include the labia and vagina.
- Secondary sexual characteristics develop from about age ten.
 - In boys they include chest hair, beard growth, lower voice, well-developed muscles.
 - In girls, they include breasts, wider hips, rounded body shape.
- Physical changes during puberty.
 - You grow fast (the 'growth spurt').
 - The pituitary gland starts to produce certain hormones, causing the reproductive organs to start functioning.
 - The secondary sexual characteristics develop.
- Emotional changes during puberty.
 - More interest in other people.
 - Sometimes you fall in love with someone.
 - Sexuality starts to play an important role in life. Someone can feel sexually attracted to people of the opposite sex (heterosexual) or people of the same sex (homosexual).
 - The term 'transgender' is used for people who (sometimes) do not identify with the gender they were born with.
 - Someone with an androgynous appearance has external features of both sexes.
- Social changes during puberty.
 - Showing more independence.
 - Enjoying being part of a group of young people.
 - Sometimes bothered by unpleasant feelings (insecurity, loneliness).

OBJECTIVE 2

You must be able to state the parts of the male reproductive system with their functions and characteristics.

- Scrotum: fold of skin surrounding the testes and epididymis. The temperature is slightly lower than in the abdominal cavity, which is favourable for the development of sperm cells.
 - Testes: produce sperm cells when stimulated by hormones from the pituitary gland.
 - Epididymis: for temporary storage of sperm cells.
- Sperm ducts: for transporting sperm cells.
- Seminal vesicles: add fluid and nutrients to the sperm cells.
- Prostate gland: adds fluid to the sperm cells.
- Urethra: transports urine and semen.
 - Semen consists of sperm cells and fluid from the seminal vesicles and the prostate gland.
- Penis: transports semen into the vagina.
 - Erectile tissue: makes the penis become erect.
 - Glans penis (head of the penis): sensitive to stimuli that could result in an orgasm.
 - Foreskin: fold of skin around the glans penis.
- During ejaculation, the semen comes out of the penis in spurts.
 - An ejaculation can feel good (orgasm, climax or 'coming').
 - You can have an ejaculation during sexual intercourse, masturbation or in your sleep (a 'wet dream').

OBJECTIVE 3

You must be able to state the parts of the female reproductive system with their functions and characteristics.

- Ovaries: this is where the development of the ova takes place.
- Fallopian tubes (oviducts): for transporting the ova.
- Uterus or womb: this is where the embryo develops.
 - The uterus has a thick muscular wall with a mucous lining.
- Vagina:
 - semen can be released here during sexual intercourse;
 - during menstruation, bits of uterus lining, mucus and blood are discharged via the vagina;
 - when the woman gives birth, the baby comes out through the vagina.
- Inner labia: create the mucus that lubricates the entrance to the vagina.
- Outer labia: outside the inner labia.

- Clitoris: sensitive to stimuli that could result in an orgasm.
- Hymen: a membrane around the entrance to the vagina.

OBJECTIVE 4

You must be able to list the characteristics of sperm cells and egg cells.

Sperm cells	Egg cells
very small	relatively large
can move (with the flagellum)	cannot move
do not have any food reserves	contain a lot of stored food
many millions per ejaculation	usually just one ovum every four weeks

OBJECTIVE 5

You must be able to say what ovulation and menstruation are and say when these processes occur in the menstrual cycle.

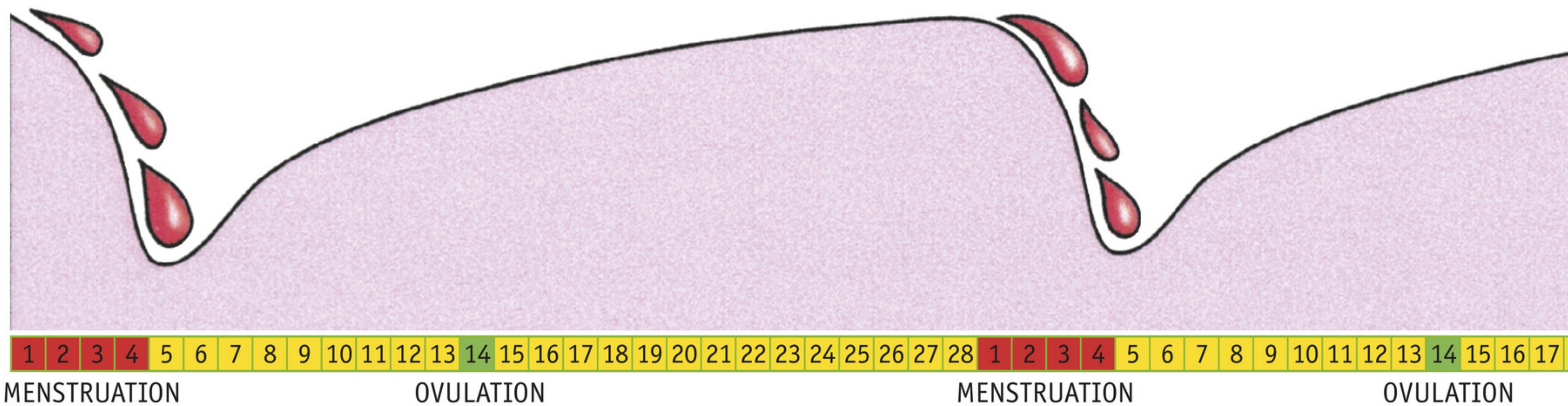
- Ovulation: the term for when an egg cell is released from an ovary.
 - After ovulation, an unfertilised egg cell lives for 12 to 24 hours. After that, the ovum will die and the residues will be absorbed into the bloodstream.
- Menstruation (having a period): the loss of part of the uterus lining when an egg cell is not fertilised.
- Menstrual cycle (see figure 73).
 - Ovulation generally takes place roughly once every four weeks (from puberty through to the menopause).
 - Menstruation starts on average 14 days after ovulation (if the egg cell that has been released remains unfertilised).
 - Schematically:

OBJECTIVE 6

You must be able to describe the changes in the body of a woman after fertilisation has taken place.

- Sperm cells can continue to live inside a woman’s body for two to three days after ejaculation. They move through the uterus towards the Fallopian tubes.
- Fertilisation: fusion of the nucleus of a sperm cell and the nucleus of an ovum.
 - Fertilisation takes place in an Fallopian tube.
 - Fertilisation is possible if a couple have sexual intercourse during the woman’s fertile period (from approximately three days before ovulation to one day after ovulation).
 - An ovum can only be fertilised by a single sperm cell. Once the head of a sperm cell has entered the ovum, the outer layer of the ovum becomes impenetrable.
- A fertilised ovum divides a number of times. The cluster of cells that this produces is carried to the uterus.
- Implantation: the cluster of cells attaches itself to the uterus lining.
 - During the first weeks of the pregnancy, the uterus lining provides the nutrients. The cluster of cells develops into an embryo. The embryo is called a foetus from the eighth week onwards.
 - Then the placenta develops in the uterus wall.
 - The woman does not menstruate during pregnancy.
- The mammary glands in the breasts develop during pregnancy. The breasts therefore become enlarged.

▼ Fig. 73



OBJECTIVE 7

You must be able to describe a number of methods of birth control (contraception) and indicate how reliable they are.

- Birth control: a woman – usually together with a man – decides whether she wants a baby or not.
- Rhythm method: the man and woman do not have sexual intercourse during the ‘fertile period’ of about six days (three days before ovulation to one or two days after).
 - Highly unreliable, because the moment of ovulation cannot be determined exactly.
- Coitus interruptus (withdrawal method): the man takes his penis out of the vagina just before ejaculation.
 - Highly unreliable, because pre-ejaculate fluid containing sperm cells can leave the penis before the ejaculation.
- Condom: a latex sheath that is placed around the penis. A condom provides protection against the transmission of pathogens (including the AIDS virus).
 - Reliable.
- The pill: taken daily by the woman. The pill contains various hormones that prevent ovulation from occurring.
 - Very reliable.
- Emergency measures (for if something goes wrong during sexual intercourse).
 - Morning-after pill: up to three days after sexual intercourse.
 - Abortion pill: can be taken up to the seventh week of the pregnancy.
 - Vacuum aspiration: a suction pump is used under local anaesthesia to remove the uterus lining plus embryo or foetus. Vacuum aspiration is the commonest form of abortion and may be performed until the thirteenth week of pregnancy.
 - After the thirteenth week, another form of abortion (late abortion) may be carried out until the 23rd week of pregnancy.

OBJECTIVE 8

You must be able to state the parts of the uterus plus embryo with their functions and characteristics.

- Placenta: part of the uterus lining in which blood from the blood vessels of the embryo flows very close to the mother’s blood.
 - The blood of the mother stays separated from the blood of the embryo.
 - Oxygen and nutrients cross from the blood of the

mother to the blood of the embryo.

- Waste products cross from the blood of the embryo back to the blood of the mother.
- Umbilical cord: connects the embryo to the placenta.
 - Blood flows through it from the embryo to the placenta and back.
- Amniotic sac consisting of two membranes containing the amniotic fluid: protect the embryo against knocks, dehydration and temperature changes.
 - The embryo can move easily in the amniotic fluid.

OBJECTIVE 9

You must be able to describe the birth of a child.

- Labour starts with the contractions: the muscles of the uterus wall contract.
- Dilation: the uterus wall and the cervix become wider.
 - The amniotic sac breaks and the amniotic fluid flows out of the vagina.
- Delivery: powerful expulsion contractions push the baby out.
 - The head usually appears first.
- Afterbirth: the placenta and the remains of the umbilical cord and the amniotic sac are expelled.

OBJECTIVE 10

You must be able to describe what the problem is in chlamydia and AIDS.

- STIs (sexually transmitted infections) or venereal diseases: diseases that you can only get through intimate physical contact with an infected person.
- Chlamydia: the most widespread STI in the Netherlands.
 - The pathogen is a bacterium.
 - Symptoms of illness: often not present, sometimes a (watery) discharge from the urethra or vagina, pain when urinating or blood loss from the vagina.
 - An untreated chlamydia infection can cause infertility or ectopic pregnancies in women, or inflammation of the epididymis in men.
 - Contaminated people without symptoms can infect others.
 - It can be cured with a course of antibiotics.
- AIDS: the most widely known STI.
 - The pathogen is a virus (HIV).
 - In AIDS patients, the immune system’s ability to fight off all kinds of pathogens is affected. This means that there are no specific symptoms in AIDS patients.

- Infection occurs primarily from intimate contact with blood or semen, vaginal fluid, pre-ejaculation fluid or breast milk from an infected person.
- Infection usually occurs through sexual intercourse without a condom, or when intravenous drug users share needles.
- Someone who is seropositive has been infected with the AIDS virus but is not yet sick.
- AIDS is treated with HIV inhibitors, which can slow the disease down but not cure it.

EXTRA OBJECTIVE 11

You must be able to describe how the NuvaRing, the female condom, the contraceptive injection, the IUD and sterilisation can each prevent pregnancy.

- NuvaRing: has to be inserted in the vagina once a month.
 - The NuvaRing releases certain hormones so that ovulation no longer occurs.
 - The NuvaRing is highly reliable.
- Female condom: is placed in the vagina before sex and offers protection against STIs.
 - The female condom is reliable.
- Contraceptive injection: a hormone injection is given once every three months that inhibits ovulation.
 - Highly reliable, but can also have unwelcome side effects.
- Coil (IUD): is inserted in the uterus and can prevent pregnancy for about five years.
 - Copper IUD: the copper thread affects the sperm cells and makes implantation less likely.
 - Hormonal IUD: the effect of the hormones is to inhibit fertilisation and implantation.
 - IUDs are highly reliable.
- Sterilisation: the man or woman is made infertile by sealing off the sperm ducts or Fallopian tubes.
 - After sterilisation, all the functions relating to the menstrual cycle and sexuality continue as normal.
 - Very reliable.

EXTRA OBJECTIVE 12

You must be able to explain what the problem is in STIs such as genital warts, gonorrhoea and genital herpes. You have made your own summary of these.

SKILLS AND COMPETENCIES**BASICS**

- You have practised identifying and describing the various phases of a scientific investigation.
- You have learned how various opinions about sexuality are expressed.
- You have learned how to express your opinion about sexual violence and have discussed it in a group.
- You have practised reading graphs.
- You have practised getting information from flyers.

EXTRA

- You have practised making a summary.

The diagnostic test does not include any questions about these competencies/skills.

You have met a midwife in this unit. You have also seen applications in science and daily practice that use the material from this unit.

Diagnostic test

You can use this test to check for yourself whether you understand and can apply the objectives listed in the summary. Write down the answers on the score sheet in your workbook.

OBJECTIVE 1

Answer the following questions.

- 1 Which sexual characteristics are *not* present at birth: primary or secondary sexual characteristics?
- 2 Which endocrine gland produces the hormones that make sperm cells appear in the sexual organs in a boy?
- 3 What is the term for someone who is born with a penis but feels that they are a woman or girl?
- 4 What is the term for a man who feels sexually attracted to other men?
- 5 Does figure 74 show an example of a primary or a secondary sexual characteristic?
- 6 When a boy's voice breaks during puberty, is that an example of a physical, emotional or social change?
- 7 You cannot immediately see if the person in figure 75 is a man or a woman.
What is the term for this kind of appearance?

▼ Fig. 74



▼ Fig. 75



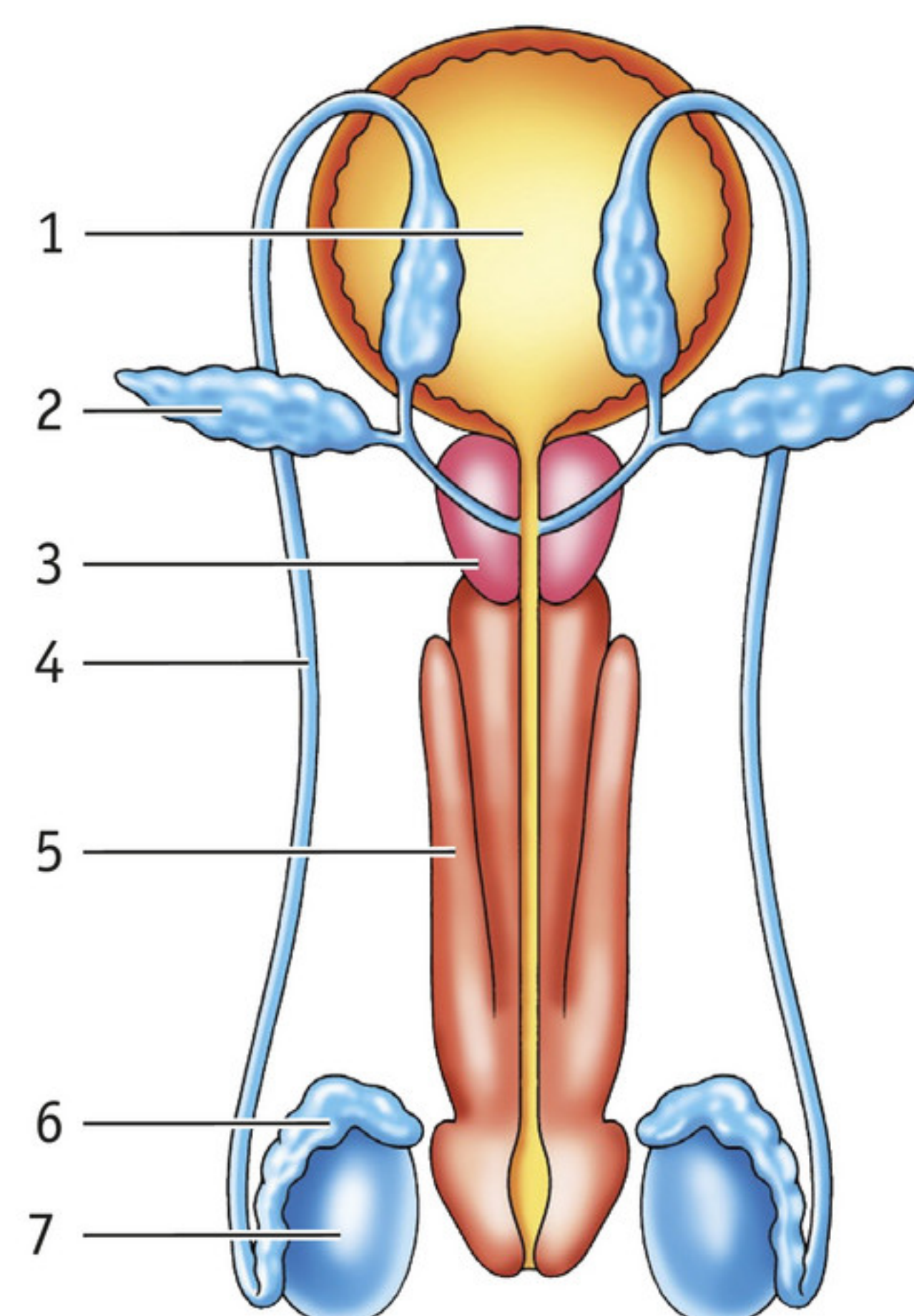
OBJECTIVE 2

Answer the following multiple choice questions.

- 1 Figure 76 shows the male reproductive system schematically. Some parts have been numbered. Which number indicates the prostate gland?
 - A Number 1.
 - B Number 2.
 - C Number 3.
 - D Number 4.
 - E Number 5.
 - F Number 6.

- 2 Have a look at figure 76. Which of the numbered organs produce components of semen?
 - A Only organs 2 and 3.
 - B Only organs 6 and 7.
 - C Only organs 1, 2 and 6.
 - D Only organs 2, 3 and 7.

▼ Fig. 76

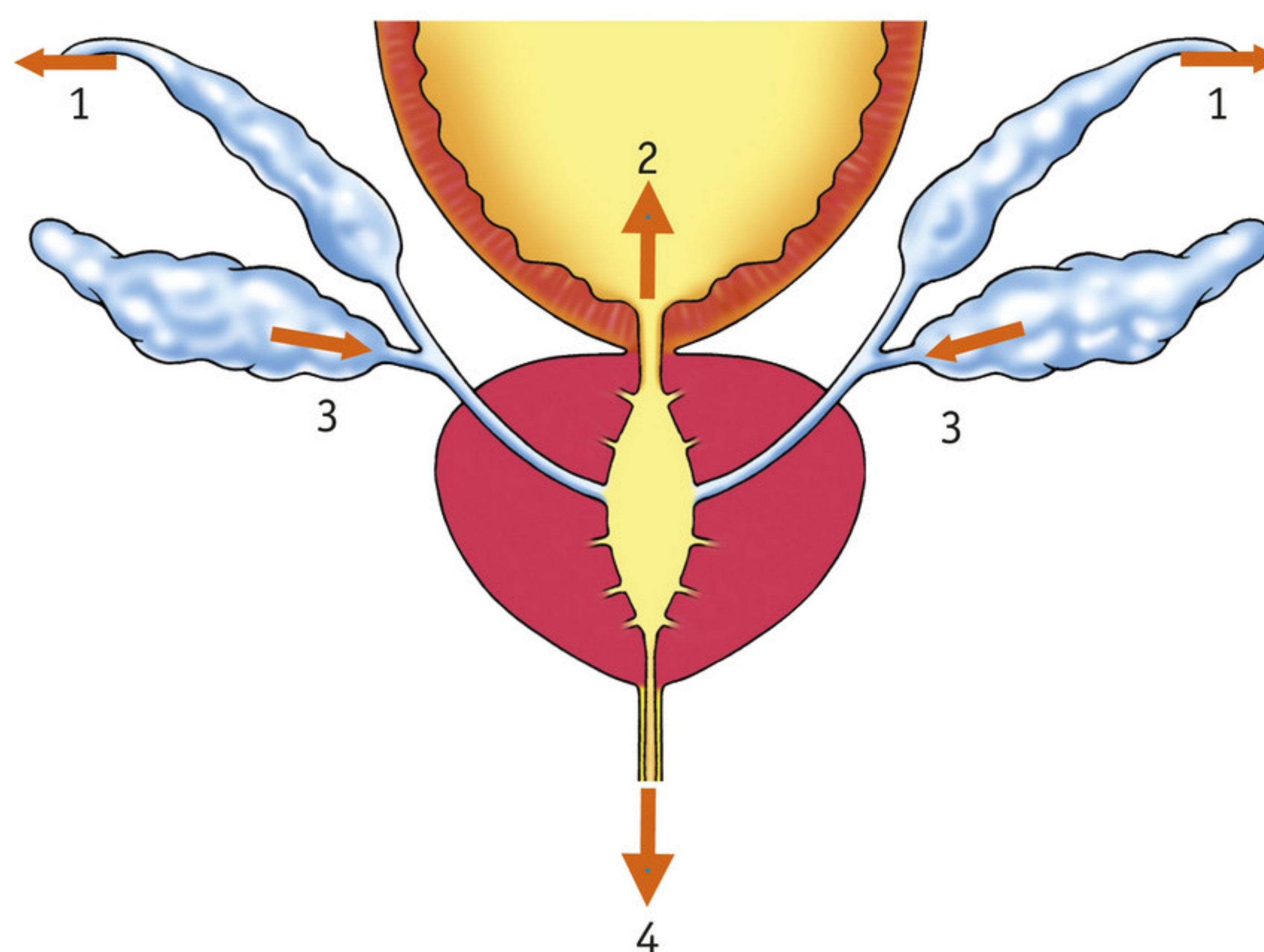


- 3 Figure 77 is a drawing of a number of organs in the male reproductive system. There are arrows in the drawing.

In which direction are sperm cells transported?

- A Only in the direction of arrow 1.
- B Only in the direction of arrow 2.
- C Only in the direction of arrow 3.
- D Only in the direction of arrow 4.
- E In the directions of arrows 3 and 4.

▼ Fig. 77



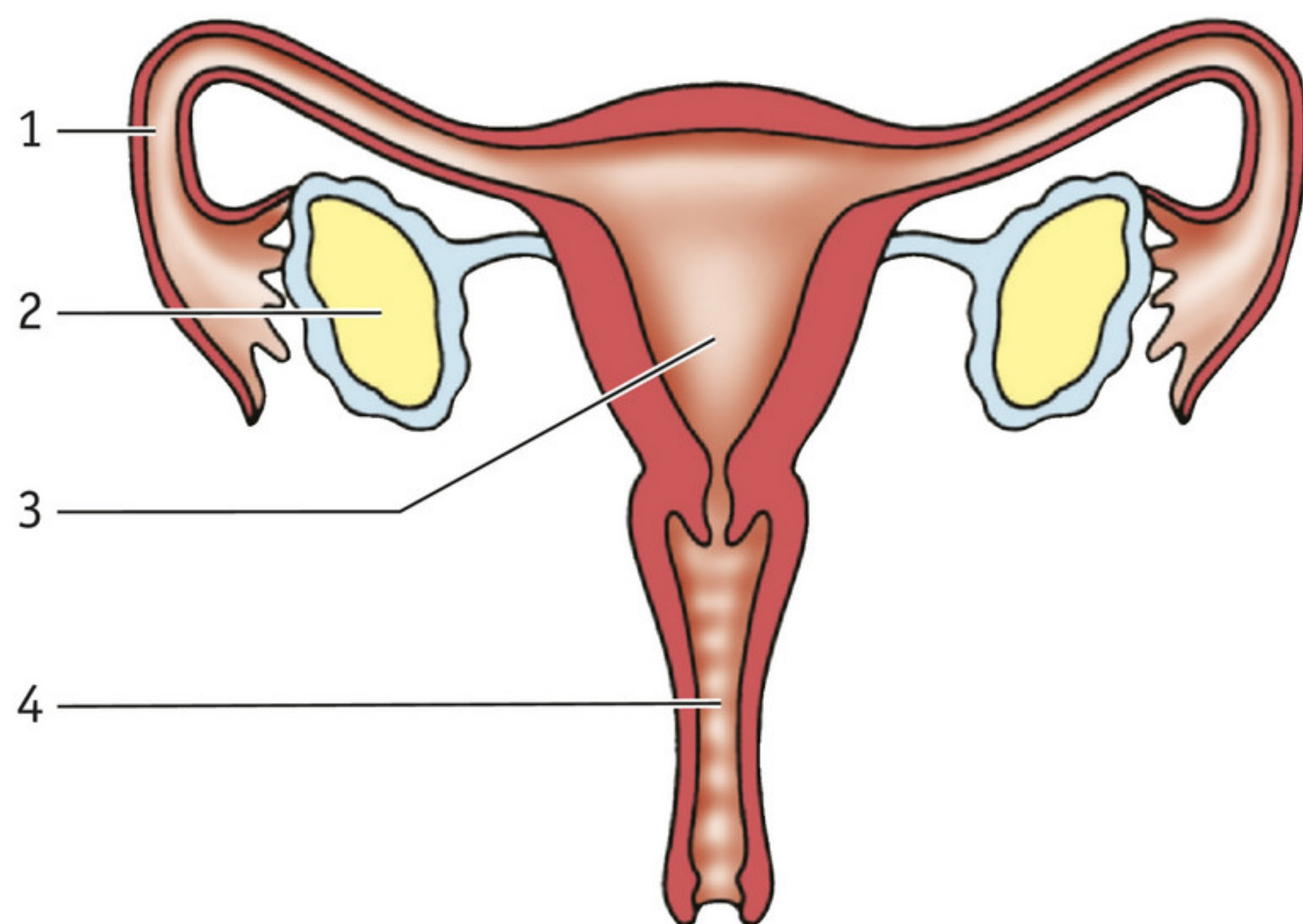
- 4 Eric says that the foreskin is the fold of skin containing the testes.
Ernesto says that the temperature in the abdominal cavity is slightly lower than in the scrotum.
Who is right?
- A Neither Eric nor Ernesto is right.
 - B Only Eric is right.
 - C Only Ernesto is right.
 - D Eric and Ernesto are both right.

OBJECTIVE 3

Answer the following multiple choice questions.

- 1 Figure 78 shows a schematic drawing of the female reproductive system. Some parts have been numbered.
- In which of the numbered parts of figure 78 are sperm cells first deposited during sexual intercourse?
- A In part 1.
 - B In part 2.
 - C In part 3.
 - D In part 4.

▼ Fig. 78



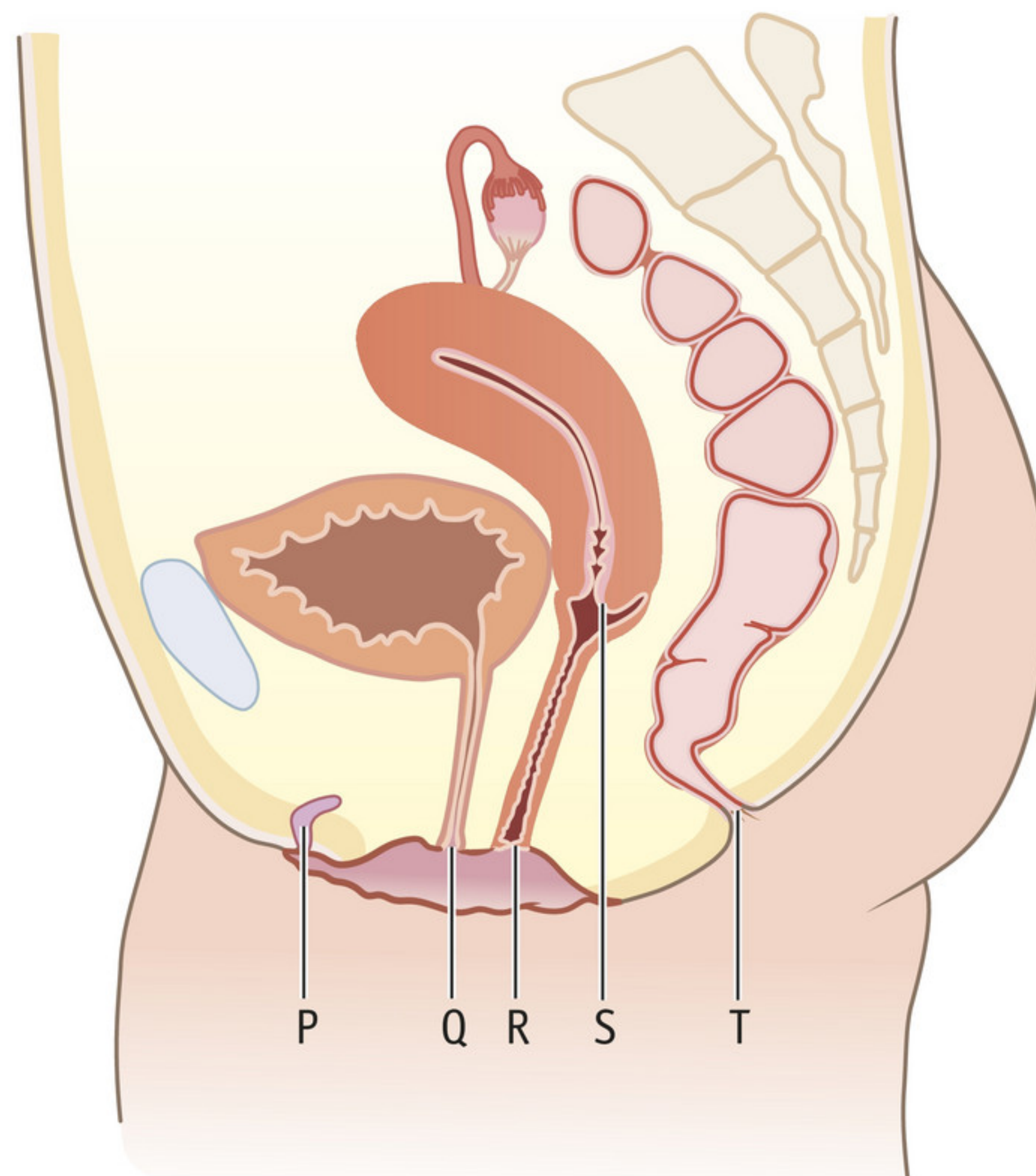
- 2 The following three statements are about a woman's vagina:
- 1 Egg cells are transported through the vagina.
 - 2 The clitoris is located at the back of the vagina.
 - 3 During menstruation, parts of the uterus lining are eliminated through the vagina.
- Which of these statements are correct?
- A Only 3.
 - B 1 and 2.
 - C 1 and 3.
 - D 2 and 3.

- 3 Figure 79 shows a schematic drawing of the female reproductive system.

What is the function of part P?

- A This part produces mucus that lubricates the entrance to the vagina.
 - B This part receives sensory stimuli that can lead to orgasm.
 - C This part is where fertilisation takes place.
 - D This part is where the development of the ova takes place.
- 4 Which letter in figure 79 shows the location of the hymen?
- A Letter Q.
 - B Letter R.
 - C Letter S.
 - D Letter T.

▼ Fig. 79

**OBJECTIVE 4**

The score sheet has a table with columns for egg cells and sperm cells:

Answer the following questions by placing crosses in the correct column.

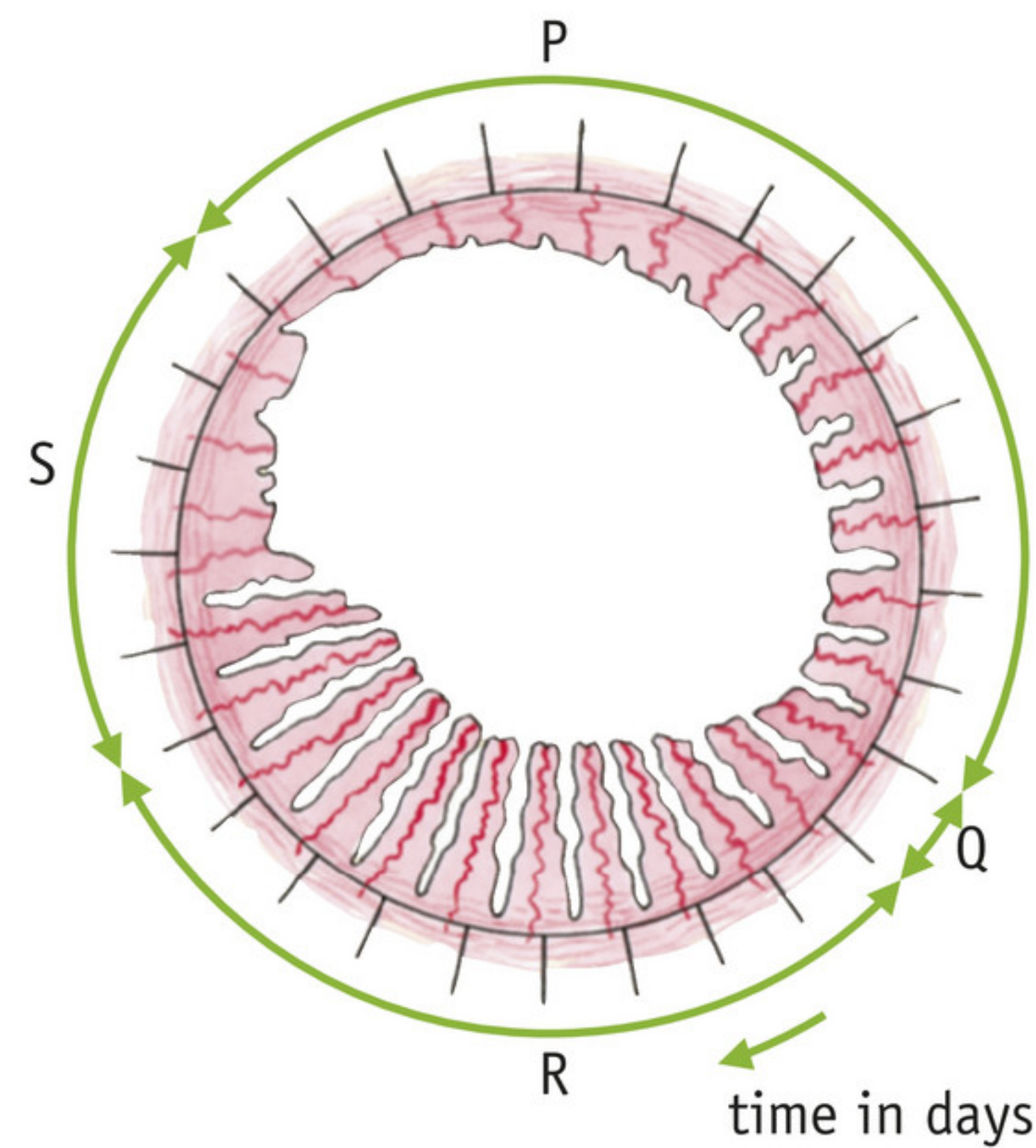
- 1 Which sex cells are able to move independently?
- 2 Which sex cells are larger?
- 3 Which sex cells contain a lot of stored food?
- 4 Which sex cells are produced in greater numbers?

OBJECTIVE 5

Answer the following multiple choice questions.

- 1 Figure 80 represents a menstrual cycle lasting 28 days. Letters P, Q, R and S indicate certain intervals within that cycle. The inner part of figure 80 is a schematic representation of the changes in thickness of the uterus lining. During which interval does ovulation take place on average?
- A During P.
 - B During Q.
 - C During R.
 - D During S.

▼ Fig. 80



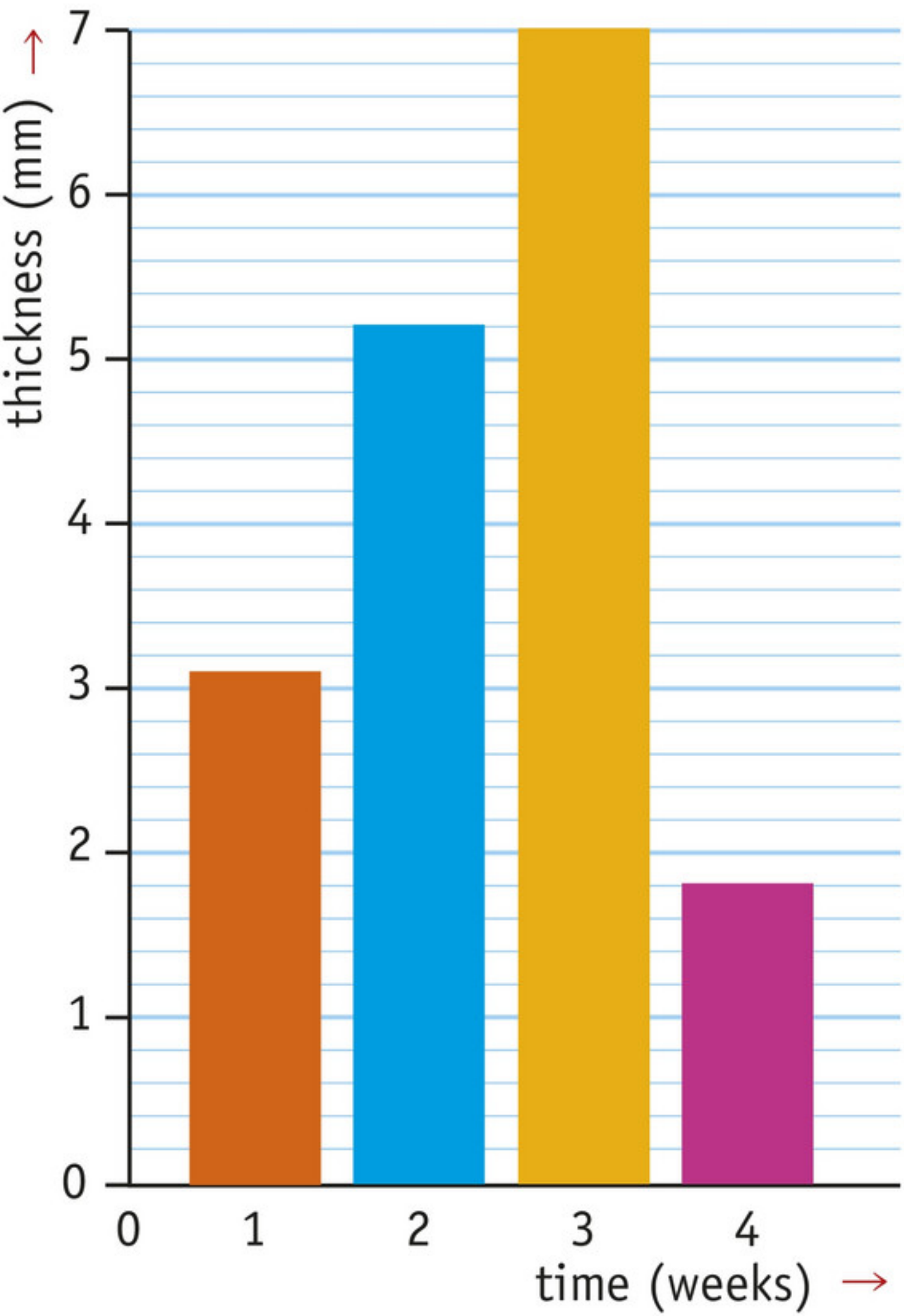
- 2 Sometime in the month of May, Vera is going to have an X-ray taken to see if her Fallopian tubes are blocked. The examination can only be done during a specific stage of the menstrual cycle, namely after menstruation is complete and before the next ovulation. Vicky has a regular menstrual cycle of 28 days. She expects her next menstruation to start on 1 May.
- Figure 81 shows a calendar for May. When planning the appointment for the X-ray, she can choose between three dates. Those days are marked on the calendar in figure 81 with a cross.
- Which date would be the best one for Vera to plan her appointment?
- A 10 May.
 - B 15 May.
 - C 30 May.

▼ Fig. 81

MAY						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

- 3 The thickness of a woman's uterus lining is measured four times at intervals of one week. Figure 82 shows the thickness of her uterus lining, represented as a bar chart. Between which of the measured timepoints does menstruation occur?
- A Between timepoints 1 and 2.
 - B Between timepoints 2 and 3.
 - C Between timepoints 3 and 4.

▼ Fig. 82



OBJECTIVE 6

Answer the following multiple choice questions.

- 1 Does a pregnant woman menstruate? And does she ovulate?
 - A She neither menstruates nor ovulates.
 - B She menstruates, but there are no ovulations.
 - C She ovulates, but there are no menstruations.
 - D Both menstruation and ovulation occur.

- 2 Figure 83 shows the body temperature of a woman during a menstrual cycle. Measuring the body temperature is one method of determining the moment of ovulation. The woman must then take her temperature at the same time every morning, before getting up. Directly after ovulation, the body temperature rises more than on any other day of the cycle. After a short time, the body temperature drops again. In which timeframe was this woman fertile?
 - A Around the 14th day.
 - B Around the 16th day.
 - C Around the 21st day.

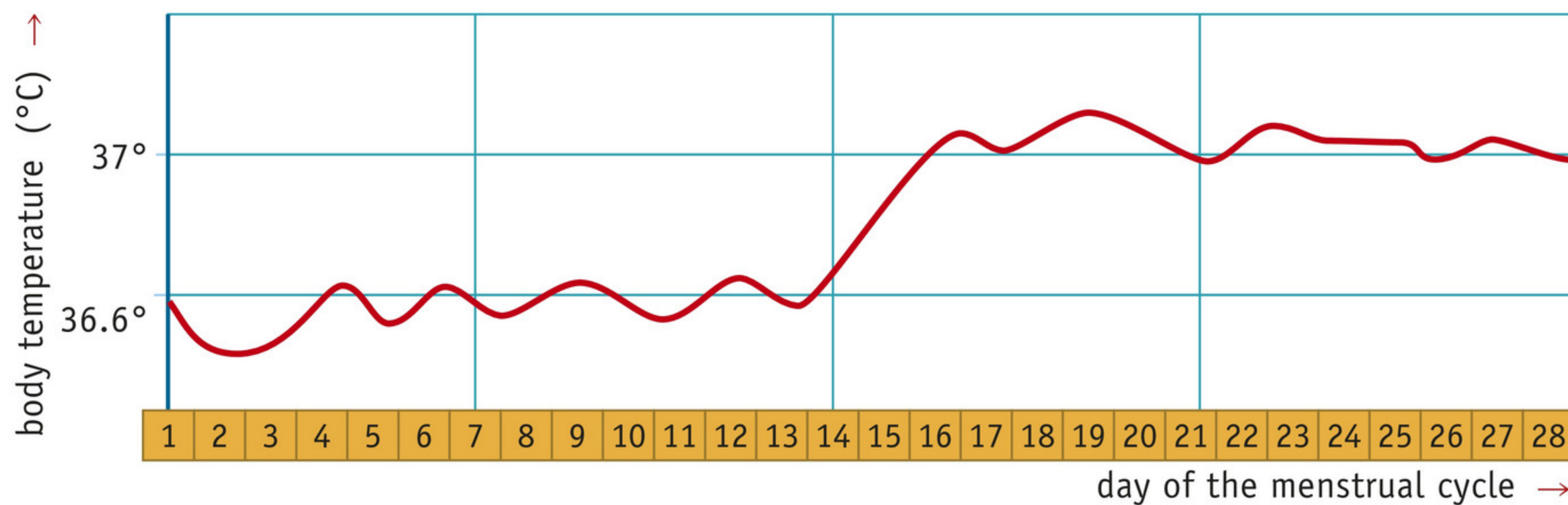
The following information is for questions 3 and 4.

Figure 84 is a schematic representation of the changes in a pregnant woman's uterus lining over the course of six weeks. Three intervals are labelled P, Q and R.

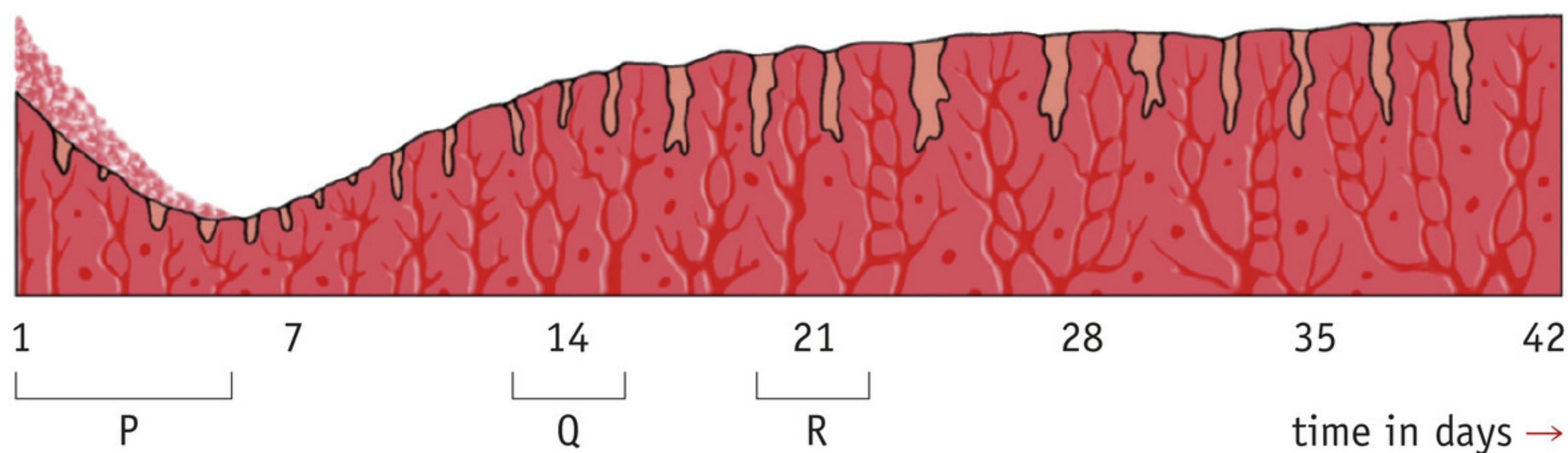
- 3 During which interval did fertilisation take place?
 - A During P.
 - B During Q.
 - C During R.

- 4 During which interval did implantation take place?
 - A During P.
 - B During Q.
 - C During R.

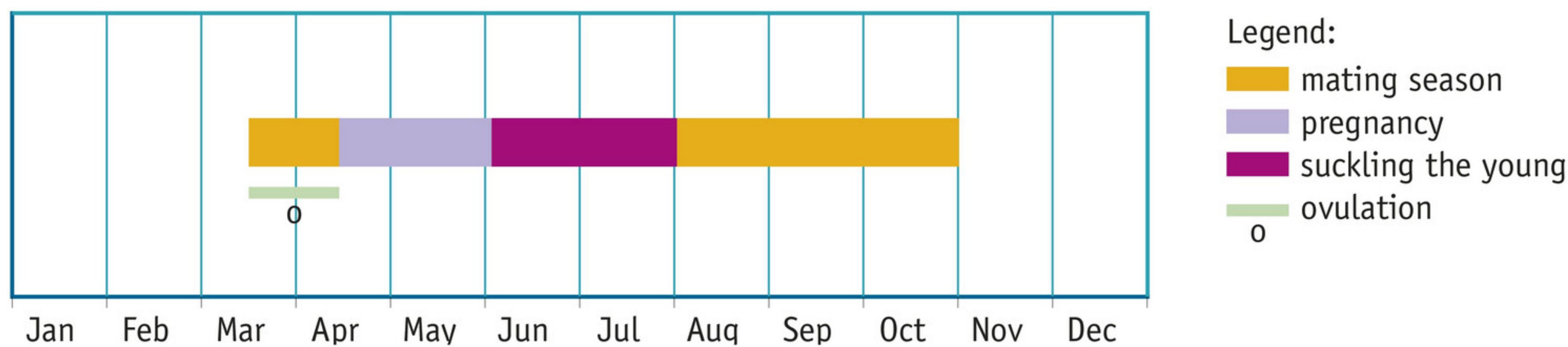
▼ Fig. 83



▼ Fig. 84



▼ Fig. 85



- 5 The structure of the reproductive organs in mammals is similar to that in humans. In mammals, the male uses its penis to place semen in the female's vagina. In animals, that is referred to as *mating*. When two bats have mated, the sperm cells can be stored in the female's uterus for months. Mating is rare during winter months. Most females only have a single offspring each year. Figure 85 shows you when various events take place that are related to the reproduction of bats in the Netherlands. Two bats mate at the beginning of October. According to figure 85, when can fertilisation take place as a result of that mating?
- Within one day of mating.
 - About two weeks after mating.
 - About six months after mating.
 - About one year after mating.

OBJECTIVE 7

Say whether each of the following statements is true or false.

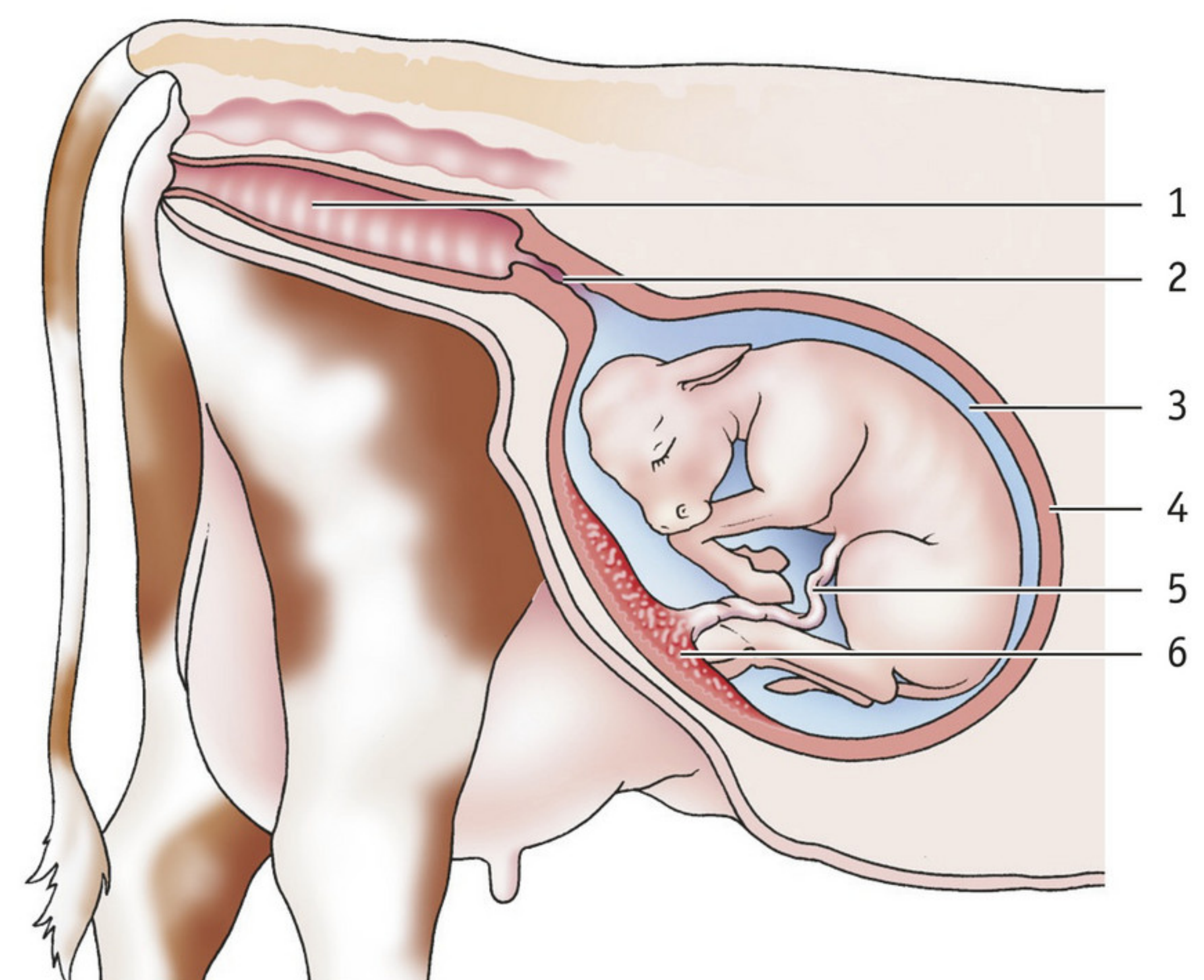
- A man and woman who are using the withdrawal method do not have sexual intercourse in the days around the menstruation.
- The pill provides protection against pathogens.
- If the morning-after pill is taken three days after sexual intercourse, the method is no longer reliable.
- Vacuum aspiration can be performed up until the thirteenth week of pregnancy.
- If a pregnant woman is too late for an abortion pill, she can go to the doctor for a morning-after pill.
- The rhythm method is a reliable method of contraception.

OBJECTIVE 8

Answer the following multiple choice questions.

- Figure 86 shows you a schematic cross-section of a pregnant cow. The names and functions of the reproductive organs in a cow are the same as in humans. A cow's calf will already be producing hormones such as cortisol before it is born. This hormone passes from the calf's blood to the blood of the mother animal. Cortisol affects the start of labour (contractions). In which of the numbered organs is cortisol from the calf's blood passed to the blood of the mother animal?
- In number 1.
 - In number 2.
 - In number 3.
 - In number 4.
 - In number 5.
 - In number 6.

▼ Fig. 86



- 2 In figure 86, there are blood vessels in the part numbered 5.
Which direction does the blood flow in these blood vessels?

- A Only towards the foetus.
- B Only away from the foetus.
- C Both towards and away from the foetus.

- 3 Here are three statements about why the amniotic fluid is important for the embryo.

- 1 The amniotic fluid protects the embryo against knocks and bumps.
- 2 The embryo gets the oxygen it needs from the amniotic fluid.
- 3 The embryo can move easily in the amniotic fluid.

Which of these statements are true?

- A Statements 1 and 2.
- B Statements 1 and 3.
- C Statements 2 and 3.

- 4 Figure 87 contains a schematic drawing of a part of a placenta with part of the umbilical cord. The blood in blood vessel P flows from the placenta to the embryo.

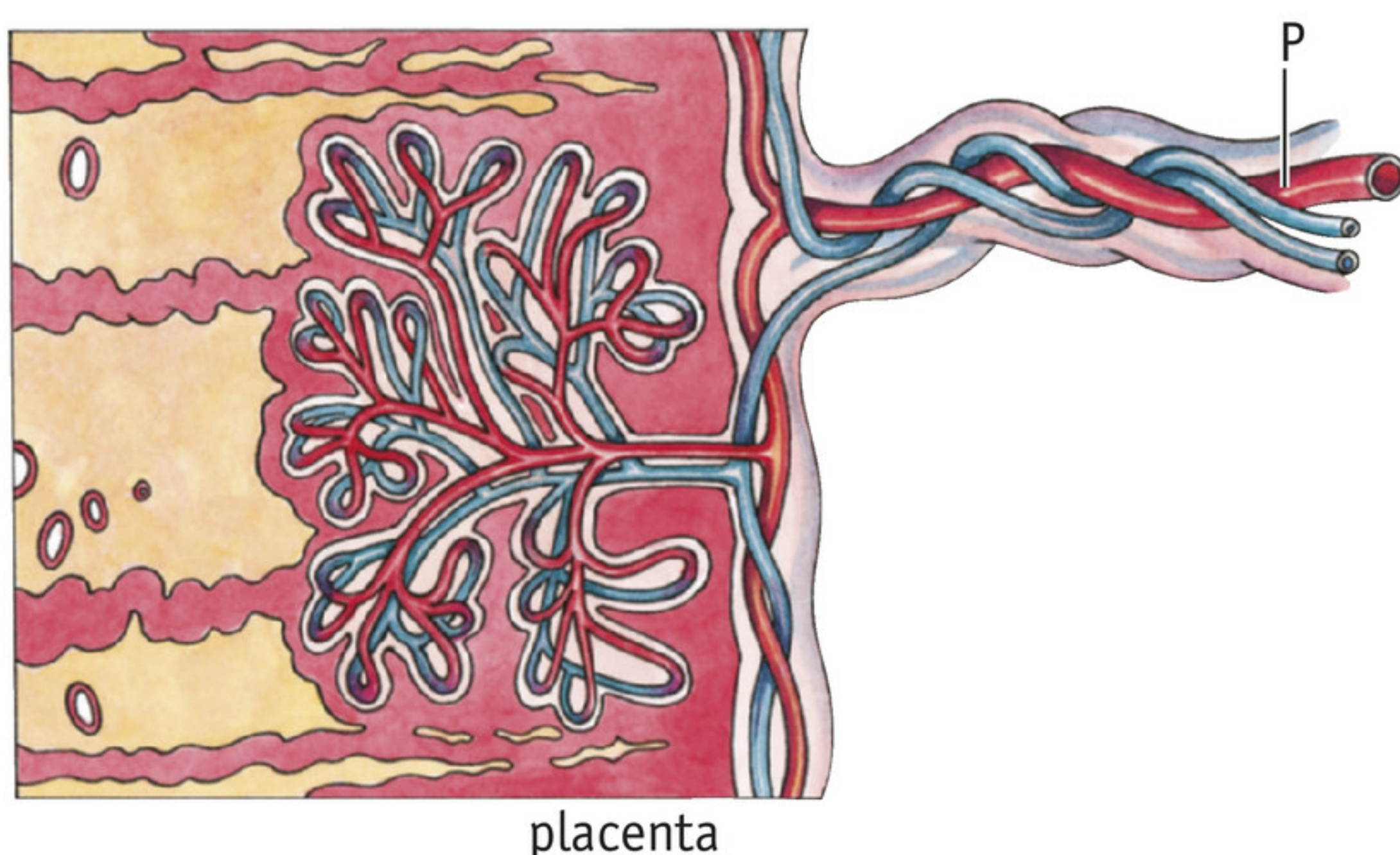
Two statements are given below about the blood in blood vessel P.

- 1 The blood in blood vessel P contains a lot of glucose.
- 2 The blood in blood vessel P contains a lot of waste products.

Which of these statements are true?

- A Only statement 1.
- B Only statement 2.
- C Statements 1 and 2.

▼ Fig. 87



OBJECTIVE 9

Answer the following questions. Use figure 88 for questions 1 and 2.

- 1 What were the abdominal cramps that the woman from figure 88 was experiencing?
- 2 Which stage of labour had already started as they were on the way to the hospital? Quote the text that tells you that.

▼ Fig. 88

Abdominal cramps

ROME – A 50-year-old woman from Benevento has become a mother, completely unexpectedly. The woman had been suffering from a swollen abdomen for some time. She did not dare go to the hospital at first, because she was afraid she might be incurably ill.

When the walls of her uterus started contracting, she thought that she just had abdominal cramps. But when the severe ‘cramps’ became too much for her, she decided to consult a doctor. He told her that she was pregnant and sent her straight to the hospital. Her waters broke on the way to the hospital. A few hours after she got to the hospital, a healthy boy called Angelo was born. The couple had been trying in vain to have a child for many years and had given up hope in the meantime. “It’s a miracle,” said the delighted mother.



▼ Fig. 89



- 3 During which stage do the strongest contractions occur?
- 4 During which stage does the amniotic sac leave the mother's body?
- 5 Figure 89 shows a stage of labour. Which stage is it?

OBJECTIVE 10

Say whether each of the following statements is true or false.

- 1 Someone can be infected with chlamydia without showing any symptoms.
- 2 Loss of blood from the vagina other than during menstruation can be a sign of a chlamydia infection.
- 3 Chlamydia can be treated by antibiotics.
- 4 Untreated chlamydia infections can cause infertility in women.
- 5 A doctor can use specific symptoms to diagnose AIDS.
- 6 If someone who is seropositive does not have any symptoms, they can still infect others with the AIDS virus.

EXTRA OBJECTIVE 11

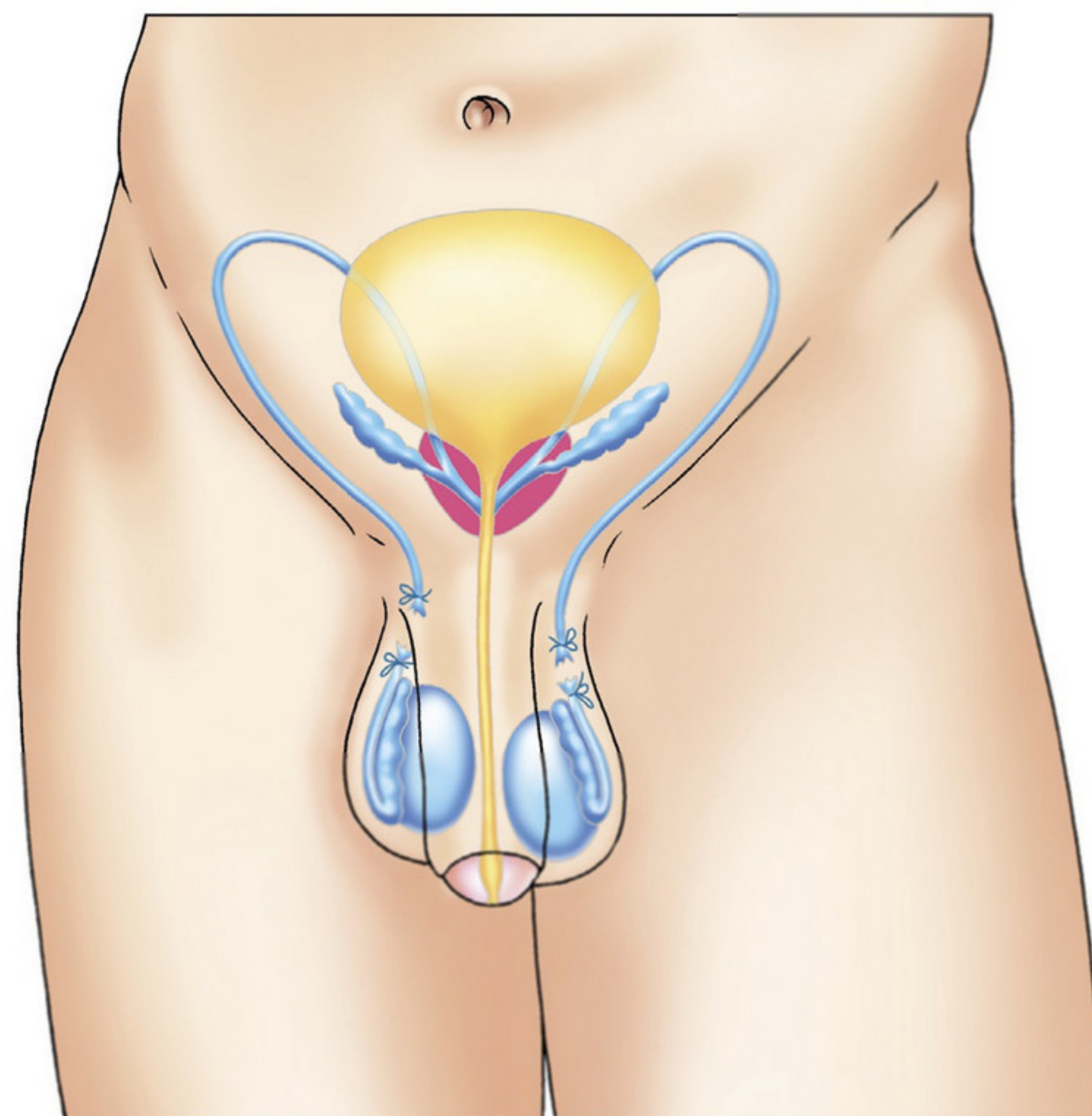
Answer the following multiple choice questions.

- 1 Certain contraceptives can greatly reduce the risk of getting a sexually transmitted infection. Do the female condom reduce the risk of STIs? And what about contraceptive injections?

<i>Female condom</i>	<i>Contraceptive injection</i>
A yes	yes
B yes	no
C no	yes
D no	no

- 2 Three contraceptives are: the contraceptive injection, the IUD and the NuvaRing. Which of these methods of contraception work by preventing ovulation?
 - A Only the contraceptive injection.
 - B Only the contraceptive injection and the IUD.
 - C Only the contraceptive injection and the NuvaRing.
 - D The contraceptive injection, the IUD and the NuvaRing.
- 3 Figure 90 shows the male reproductive system schematically. Is this man still capable of having an orgasm? If so, will seminal fluid still be released?
 - A No, this man cannot have an orgasm.
 - B Yes, but no seminal fluid will be released during an orgasm.
 - C Yes, but the seminal fluid in the orgasm will not contain any sperm cells.

▼ Fig. 90

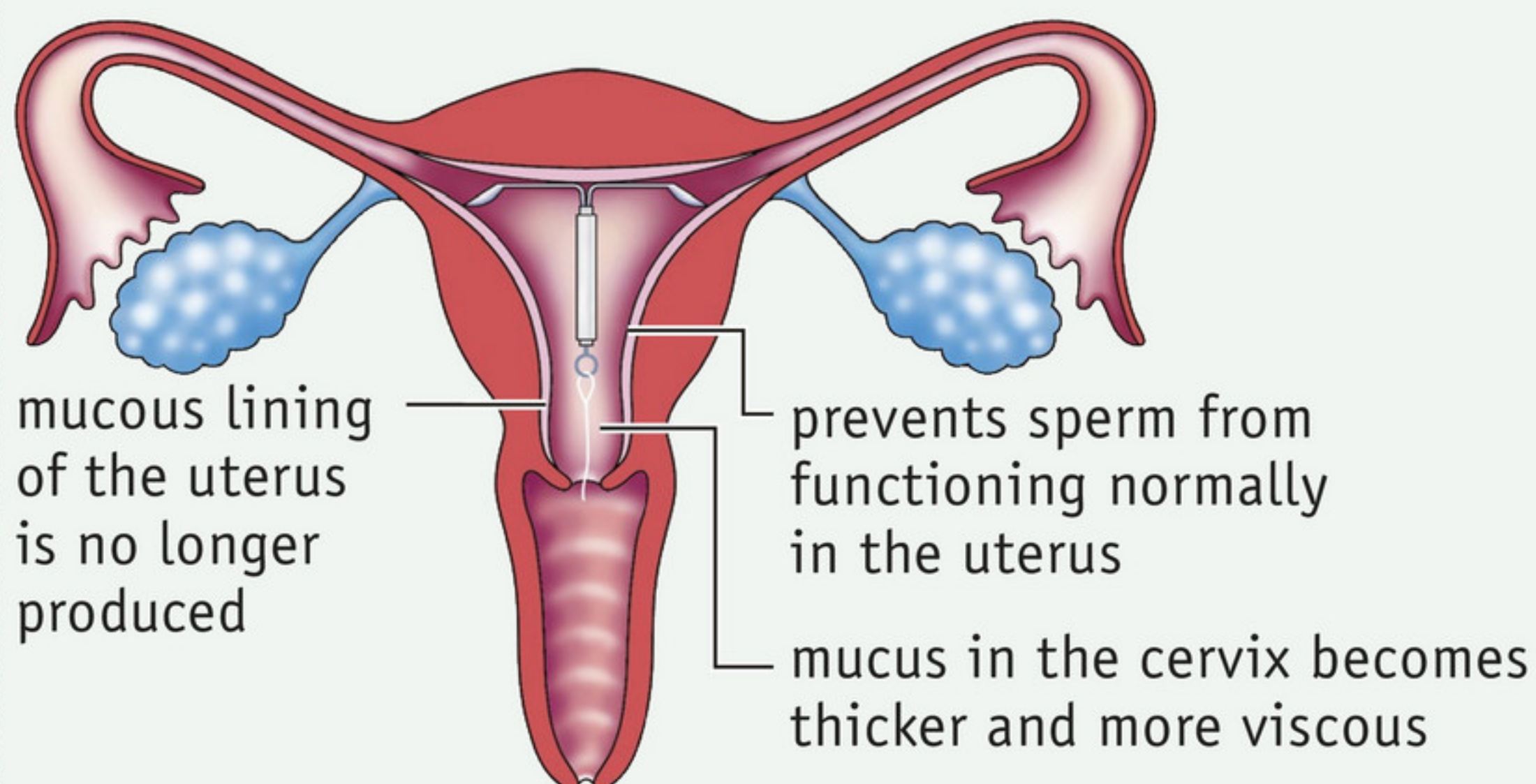


- 4 Figure 91 shows a particular brand of a contraceptive.
What type of contraceptive is being shown here?
- A A copper IUD.
 - B A hormonal IUD.
 - C A sterilisation.

▼ Fig. 91

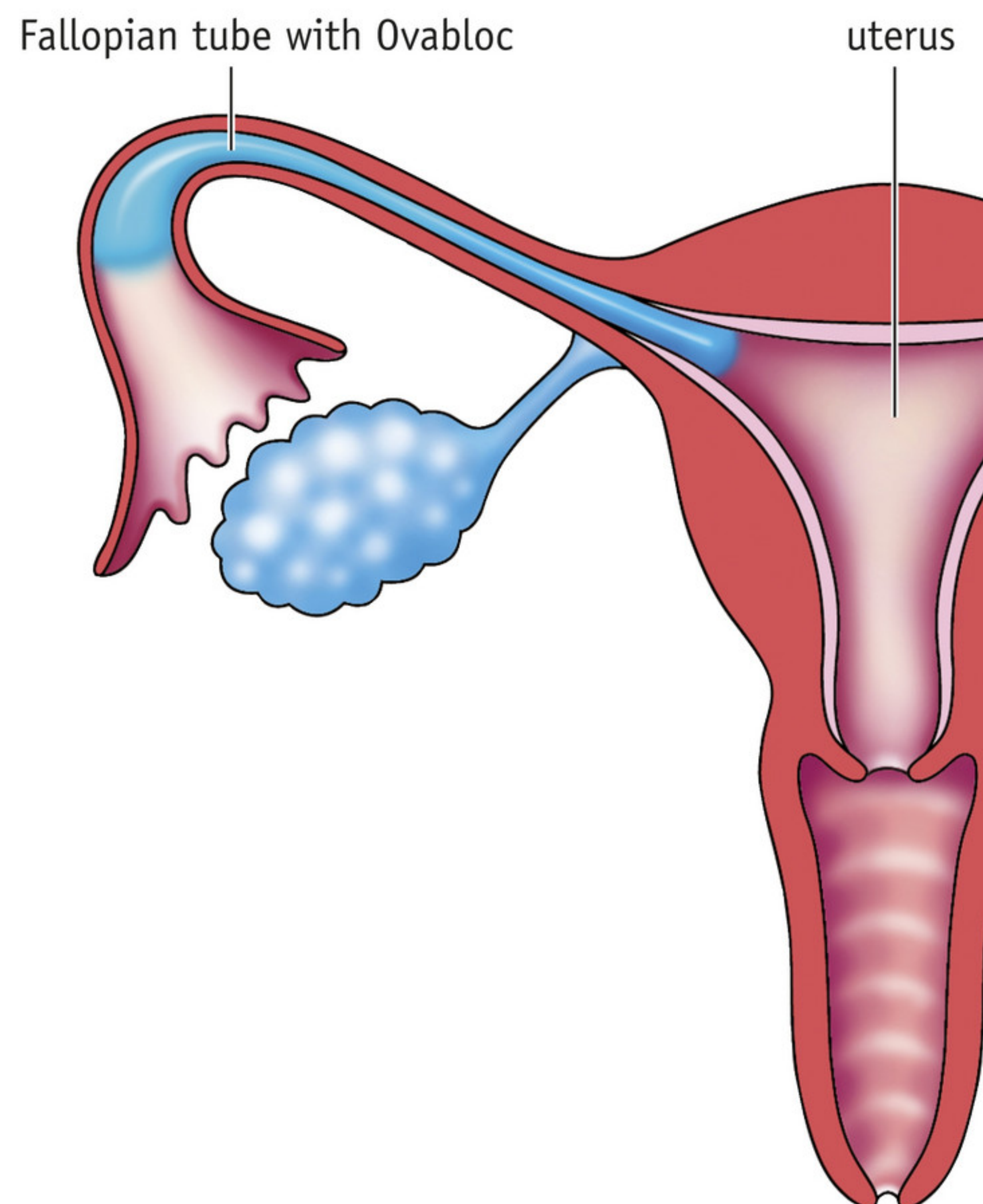
How does Mirena work?

Because Mirena works at a specific location, it does not have many side effects. The levonorgestrel is released directly in the uterus, so much less of the active ingredient is required, compared to the pill. The quantity of active ingredient that gets into the bloodstream (and therefore to the rest of the body) is as much as 60 to 100 times less than with the contraceptive pill. This is why using Mirena does not disrupt the normal cycle. Another feature of Mirena, compared to the pill, is that you do not have to remember it every day.



- 5 The Ovabloc method is a way of preventing pregnancy in which the Fallopian tubes are closed off using a latex rubber plug (see figure 92). Which other contraceptive method has the same approach as the Ovabloc?
- A The copper coil.
 - B The hormonal coil.
 - C Sterilisation.

▼ Fig. 92



EXTRA OBJECTIVE 12

Answer the following questions.

- 1 Why can't you use antibiotics to deal with genital warts?
- 2 A cold sore on the lips can cause genital herpes. Describe how this could happen.
- 3 Explain why gonorrhoea can have serious consequences for a woman if the STI is not treated.
- 4 Figure 93 gives information about an STI. Which STI does this information refer to?

▼ Fig. 93

Symptoms

Red spots occur on the skin on (or near) the penis, the labia, the vaginal entrance or the anus. These spots change to blisters and sores.

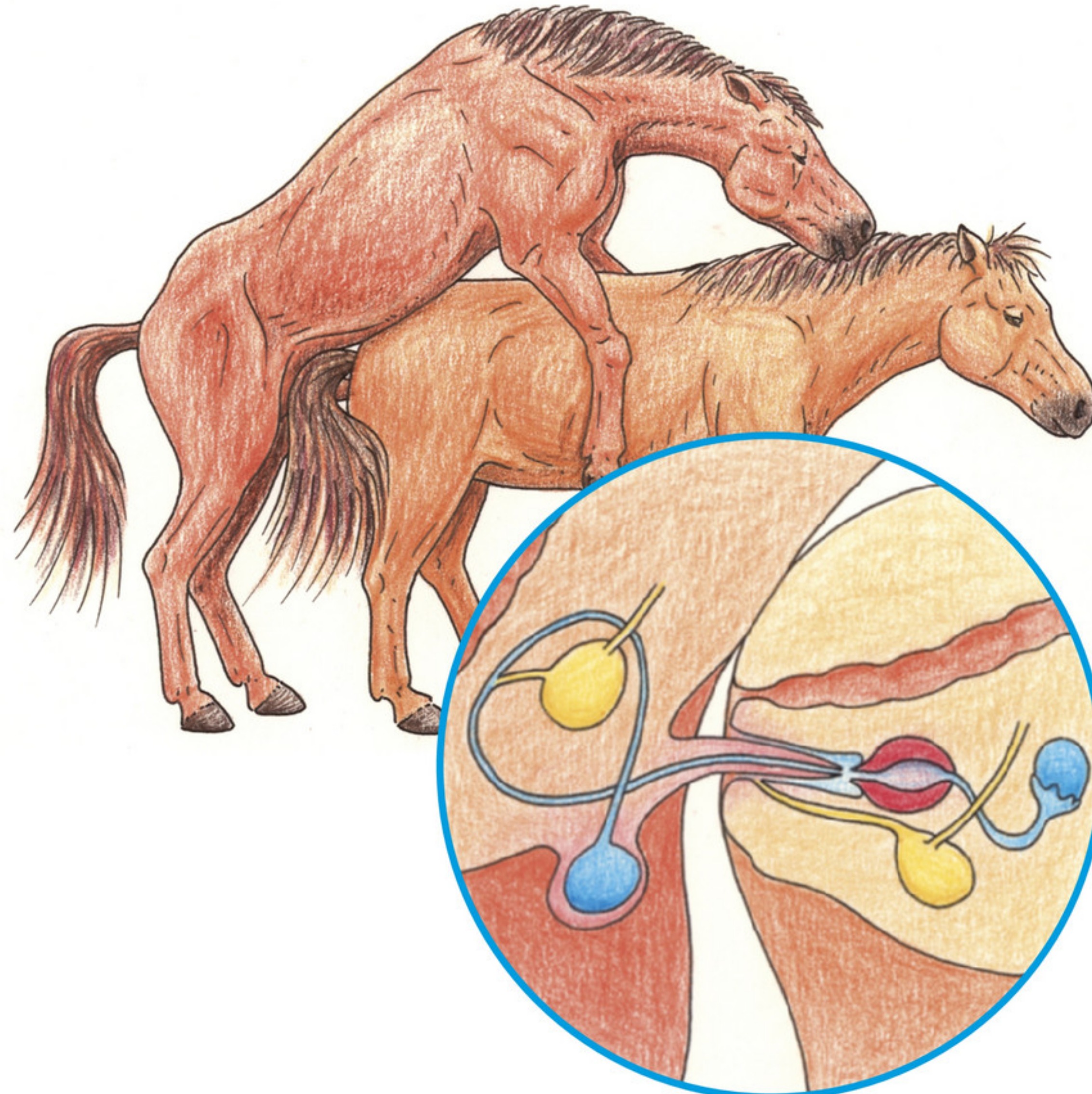
You can do the extension if you have time left over. You can choose between different topics. This unit's extension consists of three topics. You can do the exercises for them in your workbook. Your teacher will tell you how many topics you should choose.

1 Reproduction in animals

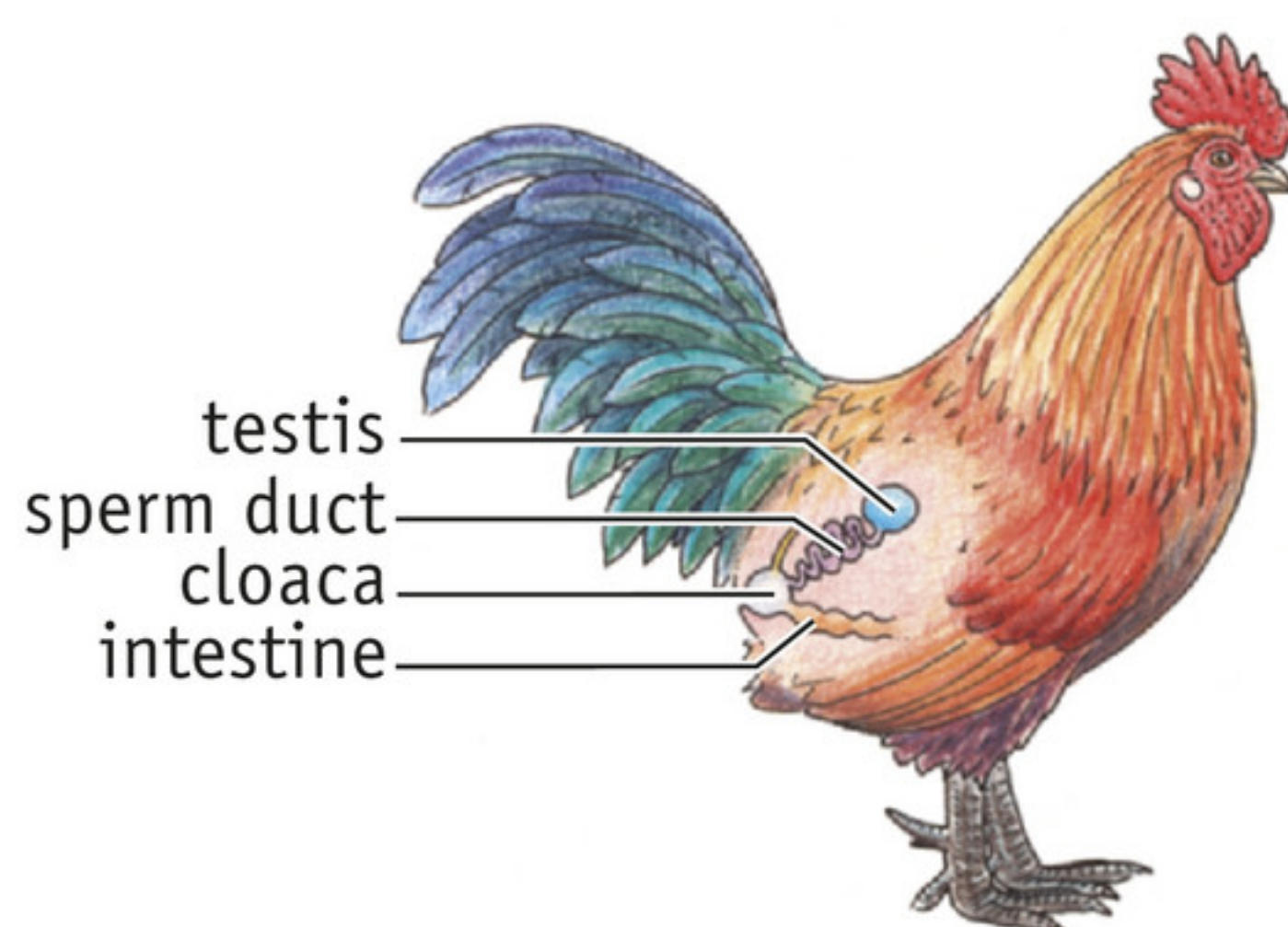
The basics were about reproduction in humans. In this extension, you will learn more about reproduction in animals. You have to answer questions and complete a table.

In the basics, you learned that the nucleus of a human sperm cell fuses with the nucleus of a human egg cell. The same thing happens in animals too. The structure of the reproductive organs in mammals is similar to that in humans. In mammals, **mating** takes place in much the same way as in humans. The male uses its penis to insert semen into the vagina of the female (see figure 94). When fertilisation takes place inside the body of the female, this is called **internal fertilisation**.

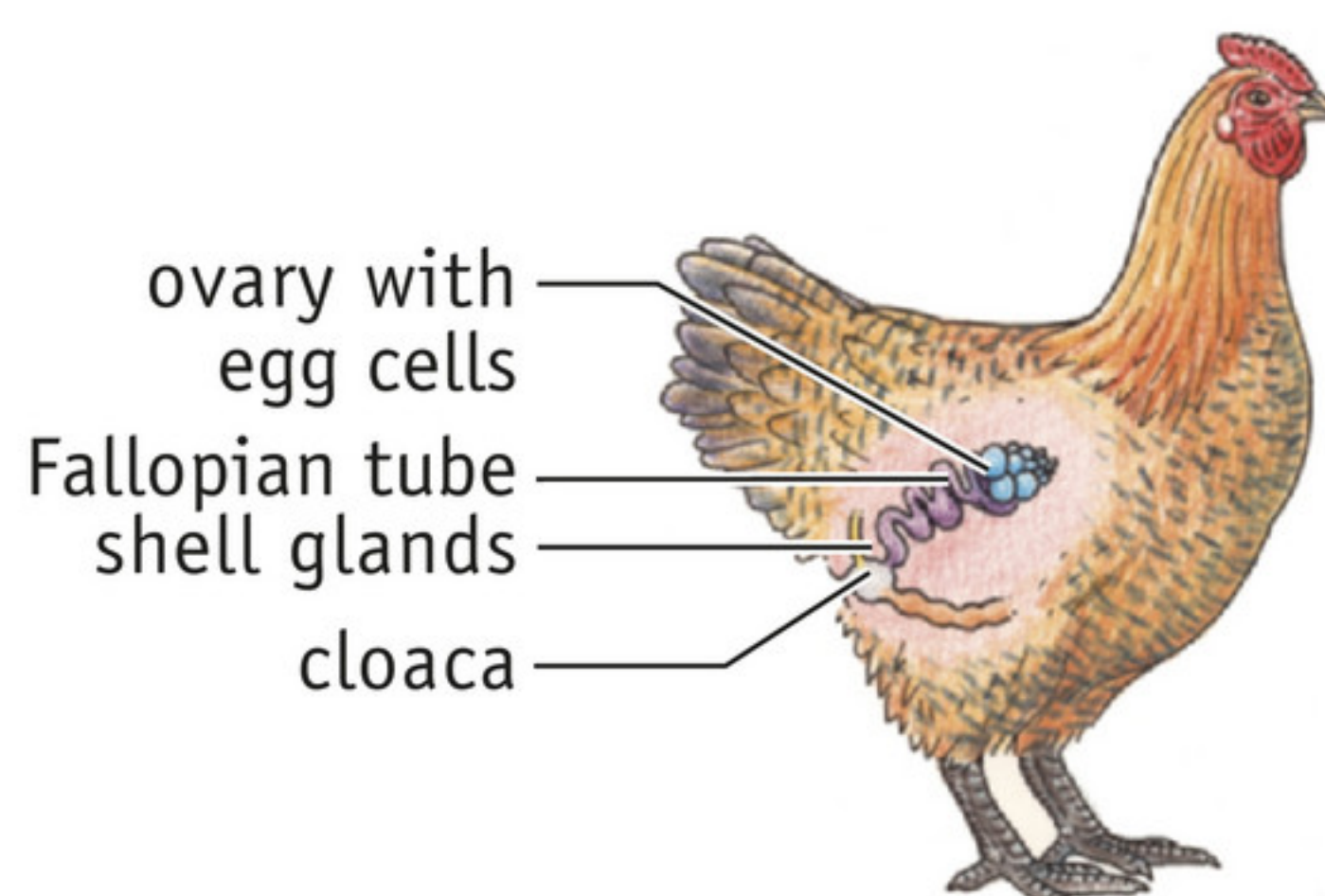
▼ **Fig. 94** Mammals mating.



▼ **Fig. 95** The reproductive system of a chicken (schematic).



1 of a cock



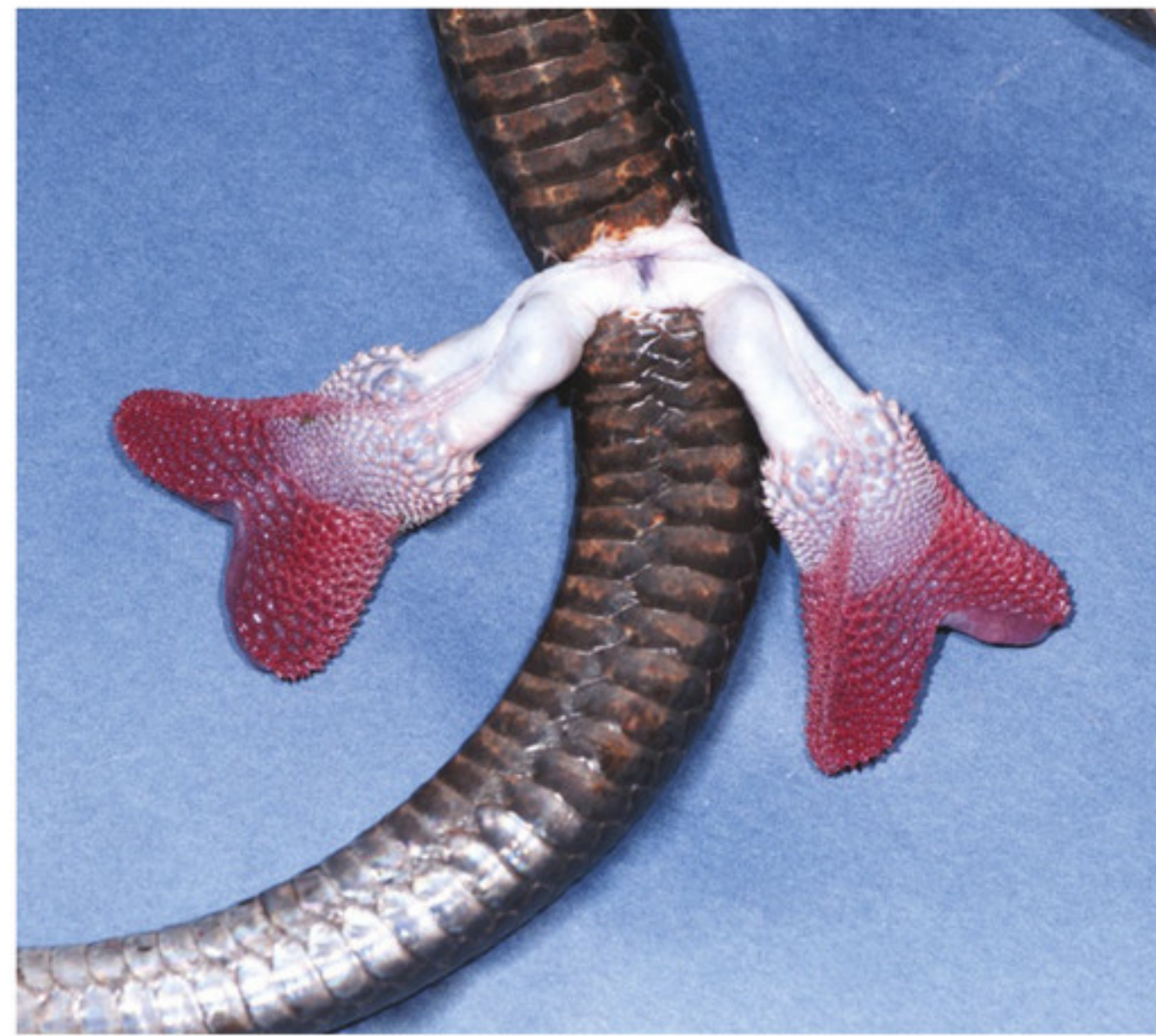
2 of a hen

Birds do not have a penis or vagina. Both males and females have a **cloaca**. The sperm ducts of the male empty into the cloaca. In the female, the Fallopian tubes empty into the cloaca (see figure 95). In both sexes, the intestines and the ureters also empty into the cloaca.

▼ **Fig. 96** Birds mating.

When mating (see figure 96), the male and female press the cloacal openings together. Sperm cells can then reach the oviduct.

Reptiles generally have a long tail, which makes mating more difficult. Many reptiles (snakes and lizards) therefore have two penises. Each of these is called a hemipenis (see figure 97). These mean that the male is able to make contact with the female both to the left and to the right of the tail. One of the hemipenises penetrates the cloaca of the female (see figure 98).

▼ **Fig. 97** The hemipenises of a snake.▼ **Fig. 98** The mating of a sand lizard shows why the double penis is needed.▼ **Fig. 99** Caviar consists of the eggs of a sturgeon. Caviar is eaten as an expensive delicacy.

1 caviar



2 sturgeon

Animals that lay their eggs on land produce a shell around the eggs. That is needed to prevent the eggs drying out. Animals that lay their eggs in water do not need an eggshell. Among animals that live in water, **external fertilisation** also occurs. Both the egg cells and the sperm cells are then deposited in the water (see figure 99). Fertilisation then takes place in the water. This is the case for fish, for example.

In frogs, the male gets on top of the female during mating (see figure 100). The male produces sperm cells at the same moment as the female deposits the eggs. The fertilisation takes place in the water. The male may stay mounted on the female for several days. In newts, fertilisation takes place in the cloaca or in the oviducts.

WB EXERCISES 1 TO 3, PAGE 172

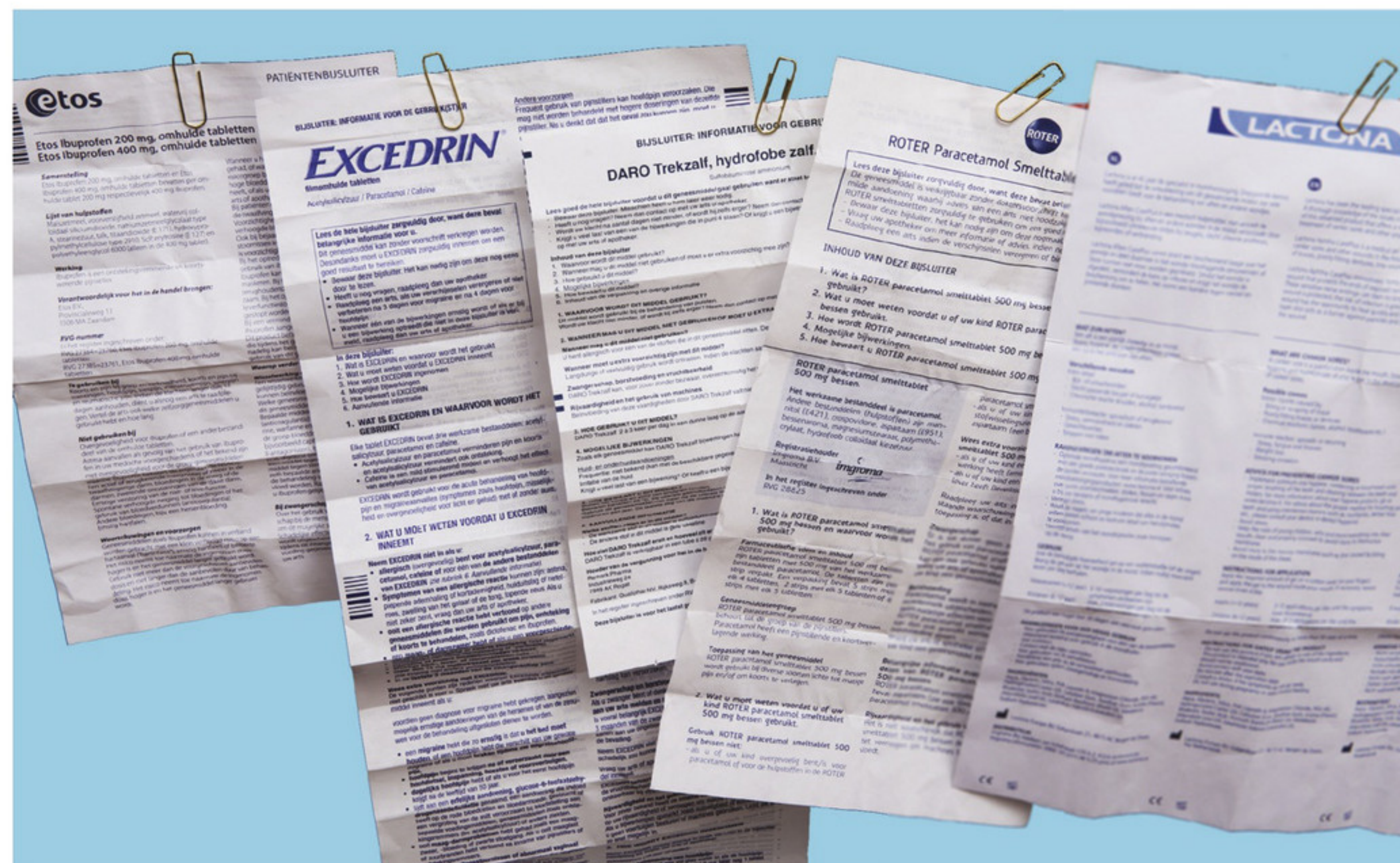
► **Fig. 100** Frogs mating.

2 The patient information leaflet for the pill

In the basics, you learned that the contraceptive pill contains hormones that ensure that the women no longer has ovulations. But the pill prevents pregnancies in other ways as well. That is stated in the patient information leaflet. In this extension, you will be obtaining information from the patient information leaflet for a particular brand of the pill. You will have to answer questions.

In the basics, you have obtained information from the patient information leaflet of a particular brand of pill. Every medicinal product has a patient information leaflet (see figure 101). It is a piece of paper describing how the medicine works and telling you how to take it, what the risks are and what possible side effects may occur. Your workbook shows the patient information leaflet for a particular brand of the pill.

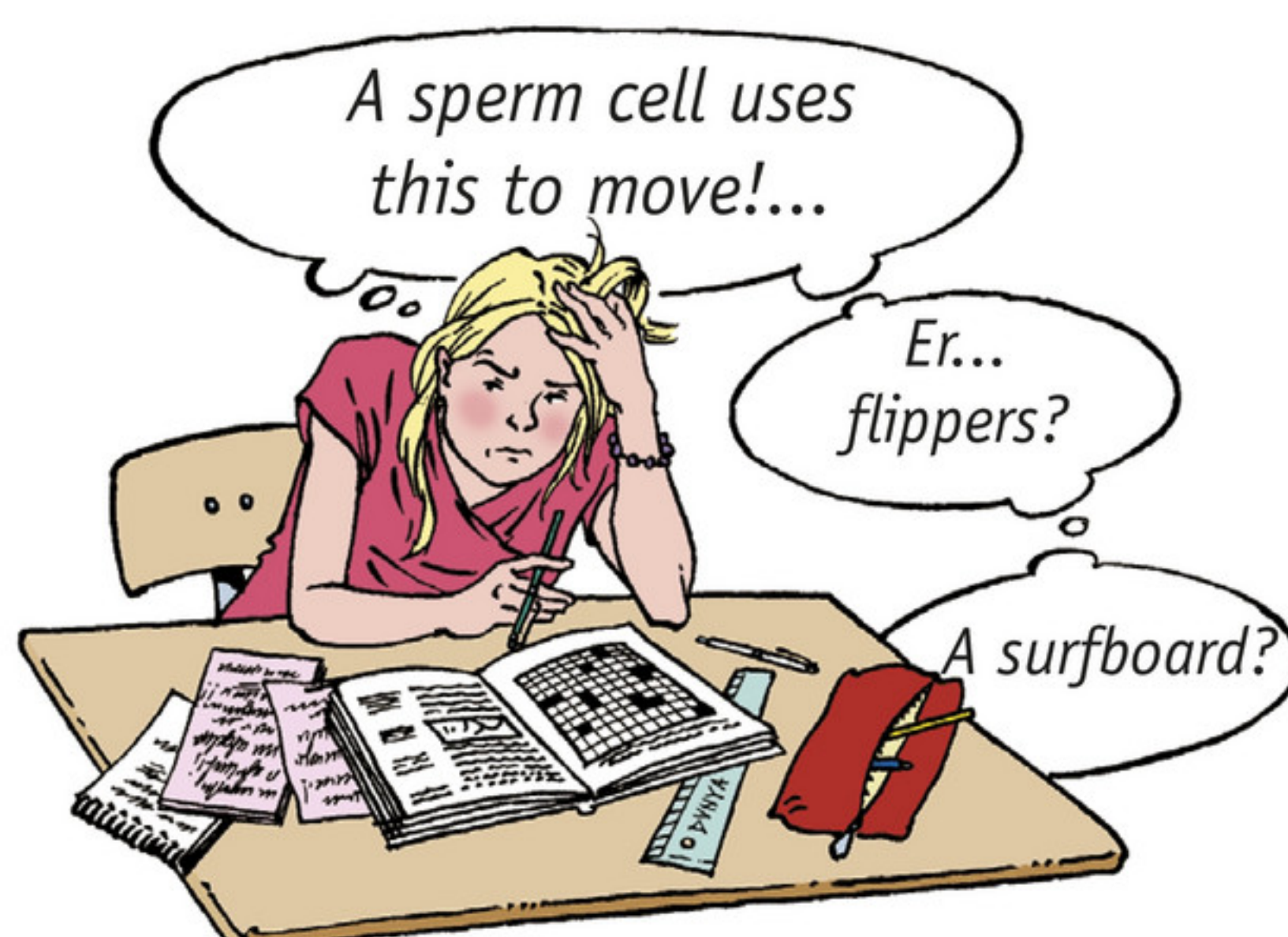
► **Fig. 101** Patient information leaflets of medicines.



WB EXERCISE 1, PAGE 174

3 Spiral puzzle

▼ **Fig. 102**



In the basics, you have learned all sorts of new words. You will find the descriptions of a number of those words in your workbook. You must fill in those words into a spiral puzzle.

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- A**
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 - abortion, late 177
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 - addiction 28, 149
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 - age 56
 - agricultural methods 63
 - AIDS 186
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